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FIELD COMPETITION OF ITALIAN ARTILLERY.

AT the end of June, after the termination of target practice at the Lombradore range, Colonel Rossi, of the Ninth Regiment, decided to arrange a competition among the batteries, making them perform difficult exercises on a course presenting many declivities and obstacles of a serious nature to the passage of guns. Each battery provided a field piece for the competition. The distance to be traveled over comprised a fairly steep descent, then a short upgrade, followed by another descent into a ditch of about four meters width and having very steep banks of about three meters height, and finally up a steep incline of about twenty meters length.

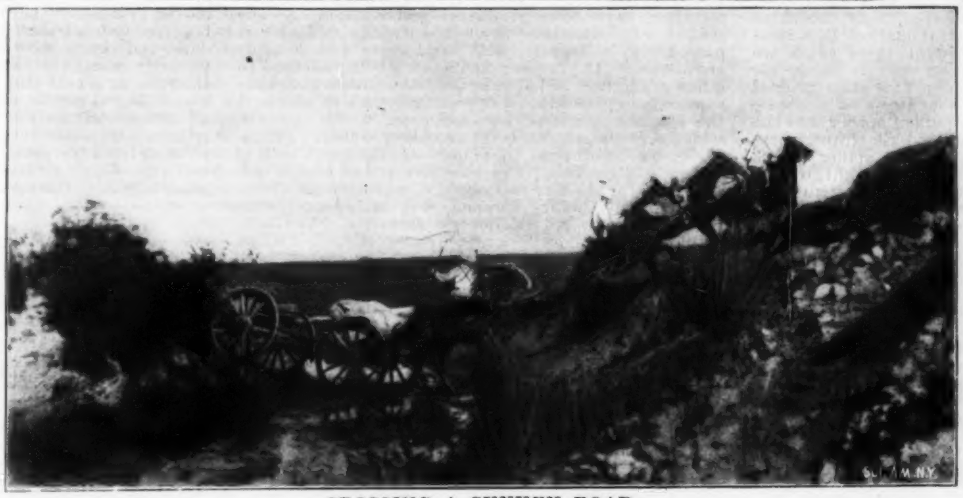
The ability to overcome such obstacles with rather heavy carriages (particularly that of the nine-centimeter gun) rests much more with the drivers than with the horses. For, barring the exceptional case of horses having a natural ability for climbing, the successful passage of an obstacle with a gun depends upon the thorough working together of the team drivers, whipping the horses up at the same time when they come to a steep up-grade, and holding them back in time when going down hill, leaving the care of guiding the field-piece to the bottom of the hill entirely to the driver nearest to the carriage. In war, field artillery will often have to travel over difficult ground, particularly in hilly country; it is therefore necessary to train horses and drivers as well to successfully overcome first slight obstacles, and then to obtain from the teams a continued maximum effort when the difficulties to be overcome require ability and quick work on the part of all.

Without this perfect co-operation, the desired result is often impossible to attain, and perhaps a slight obstacle will prevent artillery from taking up a position where it is required; or, if the field piece is brought up nearly to the top of the hill, and then, owing to insufficient training of the men and horses, the gun begins to move backward and to roll down the hill, this is liable to cause disorder in the ranks.

This training therefore is of the utmost importance, and competitions like the one referred to will undoubtedly be of advantage in that they will stir up a spirit of emulation among soldiers of different batteries; the prospect of securing a prize will cause the men to vie in zeal and activity during the entire time of the training, in the hope that their own battery will be the first of all.

The competition we spoke of could not have been more successful. All the batteries traveled over the prescribed course without any difficulty, and Colonel Rossi, to whom the initiative was due in this matter, was highly satisfied. It may be said that henceforth there will be no obstacle unsurmountable by artillery.

Lieutenant Pesci, an enthusiastic amateur photographer, has taken the snap-shots which we reproduce, some of them showing the teams throwing in their full strength to overcome an obstacle.—L'Illustrazione Italiana.



CROSSING A SUNKEN ROAD.

TAKING A HEAVY FIELD PIECE DOWN A STEEP INCLINE.

FIELD TRIAL OF ITALIAN ARTILLERY.

THE KID GLOVE AND KID SKIN INDUSTRY IN FRANCE.

THE kid glove industry of Grenoble is of ancient and doubtful origin. The town itself is situated in the center of the finest kid skin region in France, and is surrounded by mountains where the cheap labor of the peasant women can be economically employed in hand sewing. Several centuries ago Grenoble won a well deserved reputation for the quality of its gloves. The actual quantity of gloves manufactured was small in comparison with the output of to-day, but it appears that in 1691 the glove corporation of Grenoble was organized and founded, and that ever since that time records have been kept which testify to its importance. Since the invention of the sewing machine this industry has been gradually decentralized, and kid gloves are now made in almost every country of the civilized world. The American consul at Grenoble says that commercial competition — notably in Belgium, Germany, England, Italy, and Austria—following closely upon the heels of this invention, has been perhaps the chief reason why Grenoble has lost its pre-eminence in this branch of manufacture. It may justly be said, however, that Grenoble always has been, and is still, the center of the kid glove industry, especially for the finer qualities of gloves. This industry may be conveniently divided into four main branches or departments—viz.: (1) The raw skin business; (2) the dressing or alum tanning process; (3) the dyeing or staining process; (4) the actual glove making, i. e., the stretching and thinning down of the skin to its proper size and thickness, the cutting out into the shape and size required, the sewing together of the different parts, and the embroidering. The quality of the skin is best judged after the dyeing and tanning process is complete, and may be said to be based on the strength, softness, and pliability of the leather, and on the size of the skin, the fineness of the grain, and its freedom from defects, which are mainly caused by scars or diseases. These qualities of the raw skin depend on the care given to the young kid, on its breed, on the nature and abundance of its food, and on climatic influences. The finest kid skins are undoubtedly to be found in France, but this does not mean that French skins are uniform in quality. For instance, in the departments of Savoy and Upper Savoy, the skins, as a rule, are large and heavy, with a fine

grain for the size; they are soft and elastic, and at the same time strong, and well suited for men's gloves. The rich pasturage of this country is an important element in the superior quality of these skins as a class. In the region of the Vosges, in the northeastern part of France, kid skins are much smaller and less elastic, owing to the fact that the animals are not so well cared for. Here the poverty of the soil is one of the reasons for the inferiority of the skins. To the west of the Vosges, on the line between Paris and Lyons, the kid skins are of a better quality. Still further west toward the center of France, in Touraine especially, where the pasturage is good, and the animals well cared for, the grain of the skin is fine, the skin itself is thin and strong and comparatively free from scars and disease. Farther south, toward the Spanish frontier, the quality of the skin is inferior as a rule, the poorer pasturage and hotter climate having a marked effect upon it. The peasants in this part of France are careless in their methods of work. They neglect the kids while alive, and after they have been butchered, take the skins off carelessly and prepare them for market in a slovenly manner. At least one-third of these skins are so dry that they are fit to be used only as linings for boots and shoes. Kid skins have the same general characteristics throughout the southwest of France—that is, from the Rhone to the Spanish border and the Bay of Biscay. Kid skins generally pass through several hands before reaching the glove maker or his agent. The skins of kids which are bought by the butchers in the towns, and used as a substitute for lamb skins, are sold to the skin merchants or their agents. The skins of kids which are butchered by the peasants themselves are sold to country peddlers who wander through the region from cabin to cabin, collecting them in order to finally dispose of them at a town fair to the skin dealers or to the agents of the manufacturers, tanners, or large skin merchants. The more important butchers of the large towns sell their kid skins directly to the agents of the glove manufacturers or skin merchants. Formerly the regular fair or market brought together all the dealers in the neighboring district, who exhibited in the market place their lots of kid skins, varying in number from five, ten, and twenty to several hundreds, and sometimes thousands. These fairs were watched with the greatest interest by those who were in the skin business, as the prices obtained there for skins were an indication of the probable prices for the entire season. This is, to a certain extent, true to-day, but the town fairs no longer play the important part they did twenty years ago. The railways, the press, and general education, as well as the enormous importation of skins from the Argentine Republic, Chile, the Cape of Good Hope, Arabia, Mexico, Russia, and Asia Minor, have brought about a revolution in the skin business. The leading fairs, where kid skins are particularly in evidence, are held at the following places: Romans (Drôme), Anneyron (Drôme), St. Marcellin (Isère), Valence (Drôme), Clermont (Oise), Tours (Indre et Loire), Poitiers (Vienne), Lusignan (Vienne), Riom (Puy de Dome), Aurillac (Cantal), Chalons sur Saône (Saône et Loire). At one time the annual fair at Valence was considered by kid skin dealers to be the most important of all those held in France, because the prices obtained there regulated the year's prices for France, and probably for other countries as well. Its great importance in this business was due to the fact that Valence is situated in the center of a large, fine kid skin producing country, and its fair was held at the beginning of the season for the southern central portion of France. These conditions brought many fine lots of raw skins, several thousand dozens, to the Valence fair, which fact was sufficient to draw thither the big purchasers or their agents from Grenoble, Annonay, Paris, and other places. This fair still exists, and its prices are quoted every year, but it has lost its former importance, because its importance being recognized, speculators have manipulated the market in order to bring about fluctuations to their own advantage. In Italy the finest kid skins, many of them equal to the best French skins, come from the north, above the line from Turin to Venice. A heavy, coarse skin is found in the neighborhood of Genoa, and a finer, smaller skin in Tuscany. In Rome the kid skins are very small, and the market unimportant. Naples, a great center for the manufacture of cheap gloves, is noted for a low-grade skin, as well as Sicily, Sardinia, and Corsica. Those that come from the Abruzzi district northeast of Naples are very much better. Switzerland stands next to France in the high quality of skins produced. Spain and Portugal both produce large quantities, but as a rule they are far inferior even to those of Southern France. The best Spanish skins are to be found in Saragossa and the surrounding country. Germany produces a large number of kid skins, of which the best come from Saxony. Bavaria, Baden, Thuringia, and Silesia furnish large quantities. The best Austrian skins are to be found in the Tyrol and Styria; those from Bohemia, Hungary, and Transylvania are not so good. Kin skins from Eastern Europe, Northern Africa, South America, and Mexico are used principally in the manufacture of Suède gloves.—Journal of the Society of Arts.

FIELD COMPETITION OF ITALIAN ARTILLERY—CROSSING A SUNKEN ROAD.

THE BACTERIAL TREATMENT OF CRUDE SEWAGE.

THE bacterial treatment of sewage sludge has attracted the earnest attention of engineers and chemists, and so lately as last June a paper on the subject was read by Dr. Sims Woodhead* before the Conference of the Institution of Civil Engineers, evidently showing that leading sanitarians are working on that line. It would seem, however, that the better course would be to avoid the production of sewage sludge altogether, as is done at Exeter and Sutton. As our readers will remember,† the crude sewage of Exeter is passed into a "septic tank," and there all the solids are dissolved, the further purification being effected in a fine grain filter or bacteria bed. At Sutton the crude sewage goes direct into a coarse bacteria bed, and in it the suspended impurities disappear, while the dissolved organic matter is immensely reduced. Probably by one or other of these methods the great bulk of sewage will be treated in the future, and sludge will cease to trouble the managers of purification works. The London County Council, who at present send their sludge to sea in hopper steamers, have been making experiments on a modification of the plan first tried at Sutton. The results of these have lately been published by Dr. Clowes and Dr. Houston,‡ and form most interesting reading. Three tanks were constructed at Crossness, two (A and B) being 22 feet 6 inches long, 10 feet 8 inches wide, and 12 feet deep, the superficial area of each being $\frac{1}{181}$ acre. The third tank (C) was of less regular shape, but of the same area, and 6 feet in depth. One tank, A, was worked by itself, while C and B were worked conjointly, the sewage being treated first in C and then passed into B. The material of the bed in every case was coke of uniform size, "each fragment being about as large as a walnut." The coke would absorb 15 per cent. of its weight of water, and the coke bed, which was 4 feet deep in tank A, had a sewage capacity of 3,000 gallons, equal to 50 per cent. of the volume occupied by the coke and air space. The other two tanks (C, B) were filled to depths of 6 feet with similar coke, the sewage capacity of each being 4,500 gallons, when the bed was just filled to the surface.

The method of working was as follows: The sewage was pumped into the coke bed up to the level of the upper surface, and then remained in contact with the coke for three hours. It was then allowed to flow out by gravitation, an operation which occupied an hour, and then the coke bed was left empty for eight hours in order to aerate. The first coke bed, A, was charged with sewage on April 22, 1898, and from that date till June 23 it was charged with crude sewage twice daily, with the exception of Sundays, when it rested entirely, and of Saturdays, when it received one filling only. From June 23 it had a fortnight's rest, as the affluent was becoming foul, undue work having been put on the bed before it had become "matured." It was then filled once a day until November 7, 1898, when the double filling was recommenced and continued until February 18, 1899, with perfectly satisfactory results. It had then been charged with raw sewage 399 times, and had dealt with 847,500 gallons. During the time it had received an amount of solid sludge which, in the dry state, would weigh 32·4 cwt. This solid matter would represent 20·25 tons of sludge, containing 92 per cent. of moisture, or enough to fill the empty coke bed to a depth of 2 feet 9 inches.

The coke bed, C, was matured during the time it was gradually being filled with coke. It started its regular work on September 1, and from that date to February 18 was filled 213 times. The depth of coke was gradually increased to 6 feet, with no alteration in the quality of the effluent. The secondary bed, B, of the pair, B, C, was also matured during construction, and received its first charge on June 21, 1898. It was worked from that date until August 31 as a single or independent coke bed. During that time 244,200 gallons of crude sewage passed through it, corresponding to 5·85 tons of sludge containing 92 per cent. of moisture. Since September 1 it has been used as a secondary bed, and has received the effluent from the primary bed, C, and subjected it to a second process of treatment. This effluent is usually clear.

The raw sewage receives no chemical treatment; it is roughly screened to free it from larger pieces and from heavy mineral road detritus, but it contains all the solid suspended matter usually termed sludge. The coke beds have removed the whole of the suspended matter from the crude sewage, and they have yielded an effluent which occasionally shows a slight turbidity, apparently due in ordinary flow mainly to the presence of bacteria, but which is increased to storm flow by fine clay or mud. As to the results, the whole of the suspended matter has been removed, while of the dissolved oxidizable and putrescible matters, an average of 51·3 per cent. has been removed by the single process. The effluent thus removed remains free from objectionable odor, when it is kept in open or closed vessels, provided the bacteria in it are not removed or killed by subsequent treatment. The effluent is perfectly innocuous to fish life, and goldfish, roach, dace, and perch have lived for months in it, and apparently would thrive for an indefinite period. When the effluent is sent through a second coke bed, there is an additional purification of 19·3 per cent., making in all 69·2 per cent. The relative amounts of dissolved putrescible matter in (1) the sewage; (2) the chemical effluent from the precipitation tanks; and (3) the coke bed effluent, as measured by the oxygen which they absorb from permanganate, are as follows:

	Impurity of Liquid.	Percentage Purification Calculated on Raw Sewage.
Raw sewage	3·696	......
Chemical effluent	3·070	16·9
Coke bed effluent (single treatment)	1·799	51·3
Coke bed effluent (double treatment)	1·137	69·2
River water (high tide)	0·350	......
River water (low tide)	0·429	......

While the amounts of dissolved and suspended matter are greatly reduced, there is very little diminution in the number of bacteria. The mean of a number of experiments gives 6,140,000 bacteria per cubic centimeter in the crude sewage, with a reduction of 27·7 per cent. in the effluent for the single 4-foot coke bed. The spores were 407 in a like quantity, and were reduced 38 per cent. Further investigations showed that in 1 cubic centimeter of crude sewage there were 860,000 liquefying bacteria, which suffered a reduction of 11·3 per cent.; from 10 to 1,000 specimens of bacillus enteritidis, which is intimately connected with diarrhœa, and more than 100,000 of bacillus coli, and that these two suffered no reduction. Evidently such an effluent could not be turned into a river from which water was withdrawn lower down for drinking purposes, but that consideration does not apply at Crossness. The water there is distinctly salt and very muddy, and is also considerably contaminated with sewage. In these conditions the presence of bacteria in the effluent is an advantage, as they will continue the process of purification, aided by the oxygen dissolved in the river water. At present the County Council is discharging the effluent from the precipitation tanks direct into the river, although it contains 10 per cent. of the original sludge and 83 per cent. of the dissolved impurities. Yet under these conditions the river has vastly improved and much of the offensive mud which covered the banks has already disappeared. This purified effluent is fatal to all fish life, but when sufficiently diluted it rapidly becomes converted into inoffensive substances.

These experiments, and many others which have been made elsewhere, give us confidence that the purifying action of the bacteria beds will be permanent, and that when properly worked they will continue in operation for indefinite periods. There is little doubt that they will always be able to break up animal matter. There is a danger, however, that they may in time be silted up by other kinds of matter. After twelve months' working at Crossness each piece of coke has become partially covered with soft material, which consists mainly of coke, with some fine sand, woody and vegetable tissue, cotton and woolen fibers, and diatoms. The capacity of the 4-foot coke bed has, during the period in review, been reduced from 50 to 33 per cent. of the whole volume of the bed, and this reduction of capacity appears to be mainly due to fragments of straw and chaff, apparently derived from horse dung, and to woody fiber derived from the wear of wood pavements. It has been ascertained that the original capacity is not restored in any degree by prolonged aeration, and also that the vegetable tissue can be separated from the sewage by a brief period of sedimentation before it is allowed to flow on to the coke bed.

The volume of sewage which can be passed through the coke bed per unit of superficial area has not yet attained its maximum, since the depth of the coke bed is being increased. It originally amounted to 555,000 gallons per acre per day for the 4-foot bed, and 832,000 gallons per acre per day for the 6-foot bed. This represents one filling per day. Two fillings correspond to 1,665,000 gallons per day for the 6-foot bed. These amounts are reduced after ten months' working to 370,000 gallons per acre for a single filling of the 4-foot coke bed. A 13-foot bed has been laid down, and has passed 3,500,000 gallons per acre per day.

These experiments are most interesting, and are described in the report before us in great detail, by the aid of tables, photographs, and diagrams. They do not, however, advance our knowledge very greatly. The Sutton works have shown that a coarse grain bacteria bed will deal satisfactorily with crude sewage without any preliminary treatment by a septic tank, or by precipitation; and, indeed, there are many such beds at work in different parts of the kingdom. The Crossness trials, however, seem to demonstrate that while a coarse bed will serve well enough when the effluent is to be discharged into a tidal river, it is not of itself able to effect the destruction of dangerous bac-

* See Engineering, vol. xlvii., page 795.

† Ibid., vol. lxii., page 236; vol. lxiii., pages 192 and 294; vol. lxiv., pages 493 and 506; vol. lxv., pages 82 and 638; vol. lxvi., page 749.

‡ "Bacterial Treatment of Crude Sewage." King & Son, 2 Great Smith Street, Westminster.

teria. It cannot be assumed that the bacillus of enteric fever would die in such a filter, indeed the evidence is quite the other way. Now there is very strong reason for believing that a fine sand filter is a perfect safeguard against the passage of such germs, for on no other ground can we account for the immunity London enjoys from typhoid fever. The death rate from that cause is much less here than in Glasgow, in spite of the fact that the upper Thames suffers much from pollution. Again, the long series of tests made by the Board of Health of Pennsylvania made it clear that crude sewage can be so completely purified in a bacteria bed that it does not differ, either chemically or bacteriologically, from spring water. It is probably hopeless to expect the destruction of the microbes as long as the liquid in which they exist contains ample nourishment for them. They may possibly be poisoned under certain circumstances by their own products, but starvation offers a more certain means of destruction. In a coarse filter, with its ample water capacity and its relatively small surface, the number of nitrifying organisms on which we rely to oxidize the dissolved organic matter cannot be so great as in a finer filter, and hence it is not reasonable to expect that they will do their work as completely in a given time.

The silting up of the filters with vegetable fiber is a matter which will need to be guarded against completely, for it would be a very serious matter to have to either wash or renew the coke. A filter an acre in area and 12 feet deep would contain 20,000 cubic yards of coke, and to have to remove this even every three years would be a great expense. It is a danger one would hardly have anticipated, seeing how readily vegetable matter decays. Possibly the kind of organism which is best able to effect its destruction cannot live in the society of those which flourish in a bacteria bed, and hence the two will need to be separated. If sedimentation has to be adopted, it may be worth while to carry it out in a septic tank, and so reduce the work to be done in the filters. It must be remembered, however, that the long London sewers act the part of a septic tank to a considerable extent, and that the work of breaking down the solids into soluble bodies is carried on in them to a considerable extent.

The experiments on increasing the depth of the filters are very encouraging. If a 12-foot layer acts as well as a 4-foot layer, there is hope that still greater depths will prove practicable, and thus the area of sewage works will be greatly reduced. When the limit of natural aeration is reached, it will always be possible to adopt special means of ventilation, such as those proposed by Lowcock and Ducatt. In spite of this, however, the area of filter required to deal with the sewage of London would be very great and its expense enormous. Taking the dry weather flow at 200,000,000 gallons a day and the rate of filtration at 3,000,000 gallons per acre, these would need nearly 70 acres of filter 12 feet deep in coke. This would require 450,000 tons of coke, and it would take some years to obtain it without upsetting the market. We fear it will be some time before the entire sewage of London is dealt with bacteriologically.—Engineering.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATERIAL.*

IN our society, the president has the widest latitude in the choice of a subject for his annual address, and, indeed, there is scarcely an established custom as to its nature, but it always seems logical for him to choose a theme connected with the work to which his life has been devoted, and in which he is an expert. This would make my subject "Naval Engineering," and there are several reasons why it is particularly appropriate at this time. Although one other naval engineer has been president of the society, his address had a different theme, and consequently the subject, at least as a presidential address, will be new. Moreover, this year marks a very decided change in the personnel of engineering in our navy, so that it is particularly appropriate that one of the engineers of the old school should, at the close of this chapter in the history of naval engineering, give a brief review of some of its more important facts with respect to both personnel and material.

Every American is naturally proud of the fact that the first successful steam vessel was the work of an American engineer, but it is not so generally known that the first steam war vessel of any navy was designed by the same American (Robert Fulton) and was built in this very city in 1814. Had the war with England lasted a little longer, there can be no doubt that the "Demologos" would have created a revolution in naval architecture, but the close of the war before she was completed rendered her active service unnecessary, and she was finally destroyed by an explosion of her magazine in 1829. The advent of the "Demologos" did not create an engineer corps, nor bring any engineers into the navy, so that the real beginning of naval engineering was when the steamer "Fulton" was built, and in 1836 Mr. Charles H. Haswell, the Nestor of engineering in this country, became the first chief engineer in our navy. The "Fulton" was a small vessel of only 1,200 tons displacement, or about what would now be considered a small gunboat, but she was the beginning of what has brought about as great a change in navies as the invention of gunpowder did in warfare.

It is really wonderful to think that the man who was the first chief engineer of this first steam war vessel of our navy is still alive, in full possession of his faculties, and in the active practice of his profession to-day. One of his contemporaries some years since said that the engineer corps might consider itself very fortunate in having had for its founder such a man as Mr. Haswell, an educated gentleman and a thoroughly competent engineer. From the very first his every effort was devoted to increasing the efficiency, both of the machinery and of the officers who were to care for it, and it is not going too far to say that he has left a lasting impression by his labors, the organization and scheme of examinations having long remained as he made them.

It is a little hard for the young engineers of to-day, whose training, while it may seem to them beset with difficulties in the way of intricate formulæ and abstruse calculations, is nevertheless complete and makes them masters of an immense amount of accumulated information, to realize the difficulties under which the older engineers, even of the writer's generation, and much more so of Mr. Haswell's, labored. Mr. Haswell himself was one of the first to provide a reliable book of reference for the young engineer, where the results of experience were systematically arranged, but for Mr. Haswell himself there was nothing of this sort, and he had to create the precedents. When we look at the matter in this light, we are filled with admiration for Mr. Haswell and the men of his generation at their excellent solution of the problems which confronted them.

Without going into a detailed sketch of the work done by Mr. Haswell, it may not be amiss to recall to your minds a famous old ship, the machinery for which was designed by Mr. Haswell, who indeed made all the drawings for it himself. This vessel was the "Powhatan," which for many years was one of the finest of our old ships and rendered most efficient service. Probably every member of this society living near our eastern coast has seen this fine old ship. She was built in 1847, and remained in active service for forty years, a monument to those who had designed and built her.

In those early days the average deck officer of the navy did not look upon the steam engine as a desirable addition to a ship, but simply as a necessary adjunct that had to be endured. There were, of course, notable exceptions, and Capt. Matthew C. Perry, the first commander of the "Fulton," was a liberal-minded man to whom engineers owe a great deal. Yet even he hardly rose to the point of considering that engineers were a vital part of the ship's complement, and as such should be made to feel that they were as much officers as any others, and their men were just as truly sailors. Neither Mr. Haswell nor any of his assistants were regarded, when first appointed, as permanently in the navy, and the assistant engineers were removable summarily by the commandant of the station. Some years ago, Passed Assistant Engineer Bennett, writing for one of the reviews, in speaking of this circumstance, expressed surprise that the deck officers should not have realized the mighty force which steam brought to them and have embraced every opportunity to take advantage of it. It seemed, on the contrary, to belong to a different world from that in which they had been trained, and instead of endeavoring to become expert engineers, they regarded the machinery and all connected with it as a disagreeable necessity and left its development to the separate corps of engineers.

Among the older engineers were many men well known to all mechanical engineers in the country, who in a quiet way did very valuable work. Time will not permit, however, of mentioning them individually in such a survey as we are making.

Some years before our civil war another great marine engineer began to attract attention—Benjamin F. Isherwood. He entered the navy in 1844, so that he is really a contemporary of Mr. Haswell. It is perhaps not exaggerating to say that he is the most brilliant marine engineer whom this country has seen, and his work has made his name known among marine engineers in all parts of the world. His fame will probably rest mainly on his record as an experimentalist, in which field there are few who have ever exceeded him, either in the amount or the excellence of the work done.

The most notable of his experiments was the series which gave the complete demonstration of the relation between cylinder condensation and the rate of expansion. Until these experiments, most engineers believed that the law of Mariotte, that the product of pressure and volume is constant, was strictly applicable to steam as well as to permanent gases, and that a very large ratio of expansion with low pressures of steam would be profitable. Isherwood's experiments on the "Michigan" demonstrated conclusively that under the conditions there obtaining, of a slow-moving engine and a low steam pressure, a ratio of expansion was soon reached beyond which any increase would cause an absolute diminution of economy instead of an increase thereof, as would have been predicted from a strict adherence to Mariotte's law. Every young engineer knows this thoroughly to-day and is cautioned about it in his text books, but so far from its being readily accepted when Isherwood's experiments had demonstrated the true facts, many will remember that he was assailed in the public prints as being guilty either of hopeless ignorance or willful waste of the government money.

Mr. Isherwood was not only a splendid experimentalist, but a designer of the first rank, and an executive engineer who has not been surpassed. He was Engineer in Chief of the Navy during the whole of the war of the rebellion, and during that time was responsible for a large number of designs. Here again he was criticised from the academic point of view, and yet the very faults for which he is criticised only appear, on proper analysis, the more praiseworthy as excellent details of sound designing. He was accused of building engines which were inordinately heavy, which accusation he has never denied. To the mere office engineer this was true, but he realized what they did not that these engines had to go into the hands of men who were largely untrained and unfamiliar with machinery. The ordinary formulæ for design assume reasonably decent handling, and do not provide for the stresses due to ignorance and carelessness. Isherwood knew that the point of first importance was to build engines which would not break down, and in fact could not be injured by ignorant and careless handling. The result of this policy was engines very much heavier than would ordinarily be built, but they did not break down, and they carried our ships to victory. To my mind this was the highest proof of his talent as a sound designer. He had the courage to invite criticism from the book engineer in order that he might insure success for the country.

You all know the story of the "Alabama," and how she and her sister commerce destroyers drove our merchant marine off the ocean. The Navy Department felt it important to get a class of vessels that would be faster than the "Alabama," or any other vessel likely to be built, so that they could sweep the seas of all these commerce destroyers. A number of designers were concerned in projecting both hulls and engines to accomplish this result, but, although the great Ericsson was one of his rivals, Isherwood's ships were the only ones which really accomplished what was intended. The "Wampanoag" was the first of Isherwood's ships to be tried, and she was a magnificent success in every way, really in many ways the greatest success as a steam war vessel that the world has ever known, because she distanced everything that had preceded her so much more than has ever been accomplished before or since. The "Wampanoag" was given a trial lasting thirty-seven and one-half consecutive hours between Sandy Hook and Cape Hatteras, and for the whole run averaged nearly seventeen knots per hour. During several six-hour periods her speed was over seventeen knots, and for several single hours she made over seventeen and one-half. It should be noted also that this was not a smooth weather run, as the trial was ended prematurely owing to a gale, and for some time previous the weather was heavy. The speed made by the "Wampanoag" was at least four knots more than that of any other ship—either mercantile or naval—of her period, and in fact it remained the record speed for many years. Even the first fast cruisers of modern navies, like the "Esmeralda" and "Naniwa," while nominally credited with a higher speed, only made it over the measured mile, or for a short spurt, while the "Wampanoag's" record was, as stated, for more than thirty-seven hours. Another of the Isherwood ships—the "Ammonoosuc"—was given only a short trial, but showed qualities equal to those of the "Wampanoag." The best of the rival ships made a speed of about fifteen knots for less than an hour, and the other vessels fell below the "Wampanoag" even more than this.

It is not perhaps generally known that in calling the "Wampanoag" an "Isherwood" ship the designation is more inclusive than might be supposed at first glance, for Mr. Isherwood was responsible for those features of the hull design which affect speed. The design of the hull as a whole was worked out by Naval Constructor Delano, an accomplished naval architect, but he simply took the form of hull as designed by Mr. Isherwood and worked out the structural details necessary to carry out his ideas.

It would be supposed that Isherwood's brilliant achievements would have brought him only gratitude and thanks, but, on the contrary, his vigorous methods had aroused a great many enemies, so that at the end of his second term as Chief of the Bureau of Steam Engineering there was sufficient influence to prevent his reappointment to the office which he had so well filled, and he was banished to the Mare Island navy yard; but this only gave him an opportunity for some of his best experimental work, and the famous propeller experiments, which are still a mine of valuable information for designers, were conducted there with the assistance of Mr. William R. Eckart, a former engineer of the navy, and an honored member of this society.

After these experiments, and until his retirement, Mr. Isherwood conducted many others which have given valuable information to engineers, and it may be well in passing to remark that his reports of experiments are models to which all young engineers can refer with great profit to themselves. The thoroughness with which the apparatus under experiment is described and its dimensions given, the elegance and lucidity of the language, and the admirable arrangement, are all models of what such a report should be, just as Macaulay's style is so justly commended to all young writers.

From a remark which has just been made as to the qualifications of many of the engineers who came into the navy during the war of the rebellion, it might perhaps be inferred that there were few men of real ability, but this would be unwarranted, and would be an entire mistake. The total number of engineers was so large that it was utterly impossible to have even a majority of them skilled men, but a number of talented young engineers came into the service, and the profession generally has learned to recognize their ability from the fact that in the years since the close of the war a large proportion of the leaders in mechanical engineering in our country are men who were naval engineers during the war. The first President of this Society (Dr. Thurston), as well as the second (Dr. Leavitt), were naval engineers, and so was that other able man, Charles E. Emery, now gone to his long rest. William Everett, who became famous in connection with the laying of the first Atlantic cable, was another, and so was George Westinghouse, whose wonderful achievements, both as an inventor and as the creator of great industrial works, entitle him to be called the Napoleon of industrial engineering. Theodore Cooper, the great bridge engineer, and Lay, the inventor of the automobile torpedo, were naval engineers during the war. We must also call attention in passing to Chief Engineers Alban C. Stimers and Isaac Newton, who brought the original "Monitor" down to Hampton Roads and enabled her to whip the "Merrimac." But for their ability and indefatigable labors the results would have been very different. We might also recite case after case of gallantry and daring where vessels were saved by the skill of the engineers, where they lost their lives through attention to duty, or where they distinguished themselves specially in other ways, but time will not permit us to dwell upon these features.

During all the period which we have thus far considered, the engineers for the navy had obtained their education outside of naval influences, but in 1866 a class of young men was ordered to the Naval Academy to be trained as engineers in a naval atmosphere. A number of these gentlemen are still in the service and were chief engineers of our large vessels during the recent war with Spain. In 1871 engineer cadets were appointed for the Naval Academy, the course being for two years only, until, in 1874, a class was appointed whose course was to be for four years.

These young men were appointed by competitive examination open to the whole country, and as the course became better known the numbers who came to compete increased and their attainments became so high that an unusually able class of young men was obtained as cadet engineers. Unfortunately for the service, Congress was seized with one of its periodical fits of retrenchment, and as no patronage was affected by abolishing the cadet engineer system, the separate course for engineers was wiped out in 1882, and for a

* Annual address by President (Rear-Admiral George W. Melville, U. S. N.) of the American Society of Mechanical Engineers. New York, December 4, 1899.

time engineering education dropped out of the curriculum at the Naval Academy.

It is probably safe to say that the young men graduated from the Naval Academy under the cadet engineering system presented a higher average ability than any equal number of young men from any of our great technical schools; indeed, so great was their ability that the service was unable to retain them, but the country has profited from the training they received by their work in civil life. A number are filling positions as professors of mechanical engineering in our leading colleges, a number are consulting engineers of the highest rank, and several are engaged in the management of our large manufacturing enterprises, one (who is a vice-president of this society) being the general manager of one of the largest electric companies in the world. It is a peculiar pleasure to me to bear tribute to the talents of these young men, because a great many of them have served as my assistants in the Bureau of Steam Engineering, and, while I am naturally filled with regret that the navy should lose their services, I also feel proud that my own judgment in estimating their ability should be so thoroughly confirmed by the esteem in which they are held by engineers outside of the navy. I would not have it supposed from my remarks about those who have left the service that they took all the ability with them. Some of the most useful and accomplished officers, graduates and non-graduates, are still in the service, which I trust will be able to retain them.

In this connection, too, it is only right that I should bear testimony to the worth of the men who, at the Naval Academy, trained those young engineers. One of the earliest of the instructors was Dr. Thurston, the first president of this society, whose fame as an educator is world wide, but there were others who, while not so well known, nevertheless did splendid work. Just as I remarked at an earlier point about the work of Mr. Haswell and others as pioneers, so it was with those early instructors in engineering at the Naval Academy, who had practically no text books, and who were compelled, in the professional part of the instruction, to depend almost entirely on their own experience; further than this, they had nothing to guide them in the way of a curriculum, and they were compelled to establish one tentatively and develop it as experience dictated.

Curiously enough, just about the time when Congress was undoing the splendid engineering work at the Naval Academy, the Navy Department itself was formulating plans for vessels which should be designed along lines so different from those which had preceded that the familiar epithet applied to them—the "New Navy"—is entirely appropriate. The labors of the first advisory board made available a mass of information, as a result of which Congress in 1883 authorized the building of the four Roach cruisers, which were the beginning of the new navy. These vessels, I may say in passing, although possessing few features of novelty, as far as marine engineering in general is concerned, were nevertheless a marked change from the old wooden ships which had preceded them, and they rendered very valuable service, and are still, with modernized machinery, very satisfactory and useful vessels.

In 1885, when Mr. Whitney became Secretary of the Navy, there was inaugurated a period of great activity and progress in the Navy Department, taking what had been done by Secretary Chandler, who started the new navy, and carrying on the work along the lines of logical development. Mr. Whitney's determination was to have ships which should be fully the equals of those in any country, and it was through him that the speaker was called to the position of Engineer in Chief of the Navy in 1887, succeeding his life-long friend Commodore Loring, one of our past presidents, whose reputation as an engineer is too well known to all of you to need any praise from me.

I desire in this connection to say, that no head of an office has ever been more fortunate in the young men who have been his assistants. No one has ever had the co-operation of abler men, and this has always been rendered with a loyalty and cordiality which deserve all the praise I can give; and I say with perfect frankness that if the progress of naval engineering in our country has been great during the past twelve years, it is due in a large measure to the cordial assistance of the talented young men who have worked with me.

(To be continued.)

[Continued from SUPPLEMENT, No. 1248, page 20004.]

THE MODERN ARMOR-CLAD.

IF the armoring of the sides is serviceable for the security of the ship, the protection of its artillery is no less indispensable to its preservation as an element of combat. A ship of which the artillery was not protected would have its guns disabled in a few minutes and would consequently be put out of condition to continue the battle.

Upon the first armor-clads, the guns were protected by the armor, which covered the entire hull. Then, in order to give them a more efficient protection, the most powerful were concentrated at a point amidships, which was strongly plated. This was named the citadel. Finally, preserving only the medium-sized guns in the citadel, the large ones were placed in revolving turrets or barbettes, which were in most cases arranged forward and aft. The turrets are divided into closed, barbette, and intermediate turrets.

The first (Figs. 12, 13, and 14), which completely shield the piece and the gunners, revolve with their base in a step bearing placed beneath. This base is protected as far as to the armored deck by thick plating, and shields the ammunition hoist. The drawback to closed turrets is their enormous weight. They are almost exclusively employed in France upon the modern armor-clads (Fig. 15).

The barbettes have fixed walls, and consist, in the main, of a simple circular parapet of steel above which passes the chase of the gun. This parapet, with its iron plate bottom, is supported by steel uprights at a considerable height above the armored deck.

An armored tube protects the passage of the ammunition that comes from the hold. This system effects a saving in the weight of the armor; but it is to be apprehended that if a projectile should burst directly beneath this barbette turret, it might seriously damage it or even knock it overboard. It is therefore more prudent to cause the armored wall to descend to the protective deck. In this case, the difference in weight between the two systems of turrets will be much diminished. This is the arrangement that has been adopted in England upon the eight armor-clads of the "Royal Sovereign" type.

The barbette protects the revolving platform and gun carriage, but does not shield the gun, the gunners, or the turret mechanism against projectiles fired from military tops. In order to complete the protection, it is covered with a shield or an armored cupola movable with the platform. As it frequently happens that the thickness of this revolving cover equals that of the barbette armor, as upon the American ships of the "Indiana" type, the barbette holds an intermediate position between the two kinds of turrets and may be designated by one or the other name (Fig. 16).

In addition to their relative lightness, the advantage of barbettes is the possibility that they afford of allowing the entire horizon to be covered and of facilitating pointing.

The armor plates of the turrets are very thick. They reach a thickness of 17½ inches of Harveyized steel in England and 15 inches in France. The roof is protected with 3 or 3¼-inch plate. Turrets for guns of medium caliber are protected with 4 inch plate.

A turret of a new form will be placed upon the American type "Alabama," in course of construction. The wall, 14 inches in thickness and vertical in the rear and at the sides, will be inclined 42 degrees in front. With such an inclination it will become almost impossible for a projectile to pierce it.

When the artillery, instead of being in turrets or a citadel, is placed directly upon the deck, that is to say, without protection, the gunners are protected by steel shields which are movable with the piece and are sometimes of considerable thickness.

The maneuvering of the turrets, guns in barbettes, and projectile hoists is effected by steam or compressed water, and, upon the most modern ships, by electricity; but the apparatus are so arranged that they can be maneuvered by hand in case the mechanical systems should happen to be damaged by an accident or during the progress of a battle.

The heavy artillery, which is placed in the large turrets, has a caliber that varies from 9½ to 17 inches. In France, England, and Japan, the caliber is generally 12 inches; in Germany, 9½ inches; in Russia, 10 inches; and in the United States, 13 inches. The large Italian armor-clads have 17-inch guns weighing 110 tons and throwing projectiles weighing 1,830 pounds, capable of piercing nearly three feet thickness of iron. These very large calibers have now fallen into disfavor. Italy is substituting 10-inch calibers for them.

The turrets are placed upon armor-clads in different manners. They are two in number in the axis, one forward and the other aft, according to the English system. Each of them contains two guns (Figs. 18, 19, and 20). They are four in number upon many of the French ships of war, and are arranged in the shape of a lozenge, one forward, one aft, and one in the center on each side in a sponson. Each contains but one gun.

The artillery of medium caliber is installed in the citadel, in small turrets, or in separate positions in the interval between the large pieces, and, as far as possible, over the ammunition chambers. The guns are isolated or in pairs and are protected or spaced in such a way that the same projectile can disable but a single group containing two guns at the most. They are so arranged as to give them as wide a field of fire as possible, with the condition of having at least half of them firing directly ahead and the other half firing aft (Figs. 17, 18, 19, and 20).

The artillery of small caliber is placed by preference either upon the quarter deck and forecastle or upon the superstructures. The pieces designed to repel the attacks of torpedo boats must not be placed at much of an elevation. The special mission of the elevated pieces is to batter the deck of the enemy's ships. Such pieces are generally placed with the machine guns and revolving guns in the fighting tops of the military masts (Fig. 21). There are two such masts on the majority of armor-clads. They are of steel, with an internal spiral stairway, and each of them carries two strongly armored tops. In addition, they furnish elevated posts of observation and stations for searchlights for discovering the position of the enemy at night.

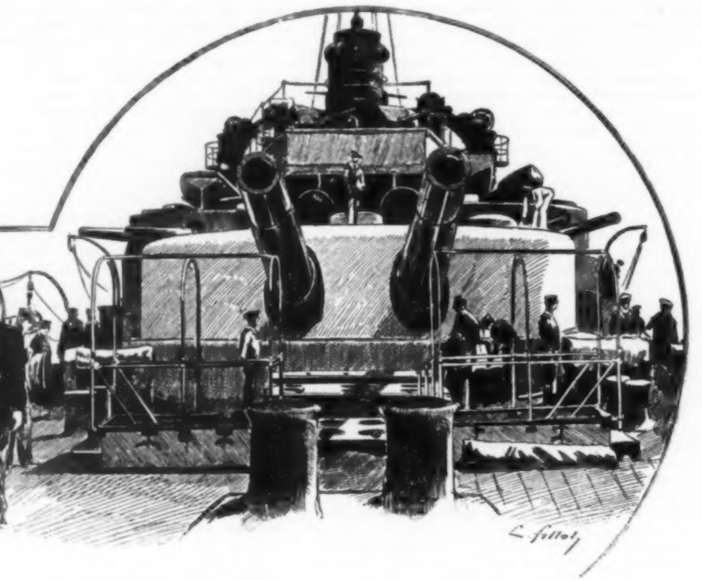


FIG. 12.—MOVABLE TURRETS WITH GUNS IN PAIRS.

FIG. 13.—TURRET WITH A SINGLE GUN BEFORE THE MOUNTING OF THE ROOF.

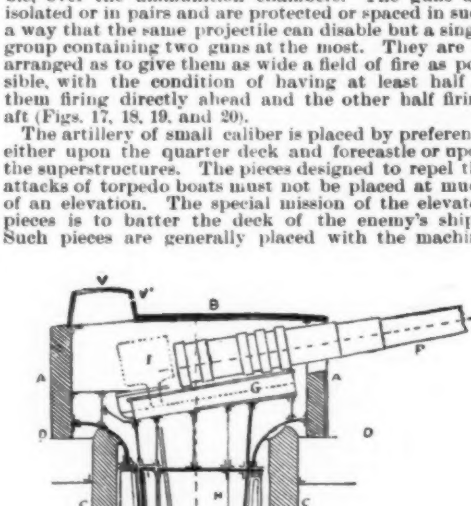


FIG. 14.—REVOLVING TURRET.

A. Steel armor of the turret. B. Roof. C. Stationary part of the turret descending to the protective deck. D. Upper deck. E. Armored deck. F. Gun. G. Carriage. H. Base of the turret revolving with the latter in the step bearing. T. H'. Metallic frames sustaining the base. I. Ammunition hoist, movable with the gun. J. Mechanism of the turret. T. Step bearing. V. Shield for the gunner. V'. Sight hole.

Torpedoes, with the gun and the ram, complete the offensive portion of ships of war. They are designed for attacking the enemy's ship at a definite depth below the water-line. Their submersion and steering have therefore to be invariable or to be corrected automatically in case of a deviation. They are fired from torpedo tubes, a sort of cannon existing upon armor-clads to the number of from four to seven forward or aft or at the sides.

These tubes are of two kinds. The ordinary tube, which does not project beyond the side of the ship, is adapted for firing in the axis (directly ahead or directly aft). The torpedo can then fall point downward without inconvenience, since it will right itself and continue its route on a straight line. The tube with a spoon (Fig. 22), which projects beyond the hull, is designed for broadside firing. When the ship is under way, if the torpedo fell with a certain inclination, the front would be deflected at the first moments of the fall by the resistance of the water, and the other extremity continuing by virtue of the speed acquired, the torpedo would be turned from the direction in which it was fired. It should fall flat in the water, and to cause it to do so is the object of the spoon, which is a prolongation of the upper part of the tube carrying a groove in which engages a T-shaped tenon fixed nearly in the center of gravity of the torpedo. At the moment that it is fired it is thus suspended at a certain distance from the side of the vessel and falls horizontally as soon as the tenon leaves the groove. Its deflection will be but a mere trifle, on condition that the rolling does not exceed five or six degrees. The tubes are either stationary or movable. The movable tubes permit of a better pointing. The firing is done by compressed air or by powder. The number of torpedoes is generally from two to four to the tube. A single one is capable of destroying an armor-clad.

Upon all armor-clads, except the most modern ones, the tubes are above water. They have the inconvenience of being visible (especially as a consequence of the projection of the spoon) from the enemy's ship, which is therefore capable of riddling them with projectiles. This is why they are now placed beneath the water line and the firing is submarine. A peculiar arrangement of the spoon prevents any deflection in broadside firing. A cap and a tight valve close the tube when the torpedo is introduced.

The defense of warships against torpedoes consists in the division of the hull into tight cells, in the use of revolving guns and rapid-firers, and in the use of the Bullivan net. This net, which is metallic, surrounds the sides of the ship, from which it is held by poles at a distance of about 23 feet. The nets are placed in position only while the ship is at anchor, or at night when an attack by torpedo boats is feared. They have the inconvenience of retarding the progress of an armor-clad and of reducing her speed by 4 or 5 knots. They prevent her from evoluting, and during a battle by a squadron it is impossible to employ them. Moreover, there is being manifested a greater and greater tendency toward the abandonment of these nets, since they do not protect the ship against the chances of explosion of an automobile torpedo, and since there is now fixed to the nose of torpedoes a sort of shears, which, after making a breach in the net, fall and allow the torpedo to pass.

The protection of a ship of war would not be complete if the safety of the commander, who must be

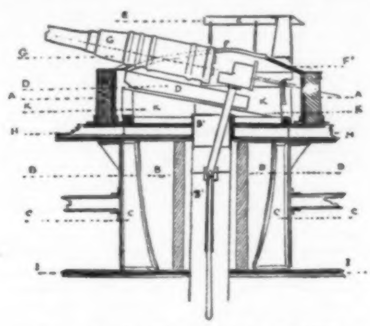


FIG. 15.—BARBETTE TURRET.

A. Stationary parapet of steel. B. Armored tube shielding the iron plate tube, B′, and descending to the protective deck. B′. Iron plate tube for the passage of the ammunition. C. Metallic frames sustaining the barbette. D. Gun carriage. E. Shield for the gunner. F. Shield to protect gunner from the fire of fighting tops. G. Gun. H. Upper deck. I. Protected deck. K. Movable platform.

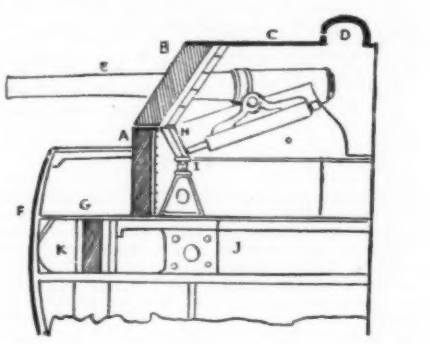


FIG. 16.—BARBETTE WITH STEEL SHELL.

A. Parapet of steel resting upon the upper deck. B. Oblique part of the steel shell. C. Roof. D. Pointer's box. E. Gun. F. Hull of the ship. G. Upper deck. H. Metallic girders supporting the movable shell of the barbette. I. Rollers moving upon a circular rail. J. Metallic frames sustaining the barbette. K. Armor protecting the base of the barbette.

FIG. 17.

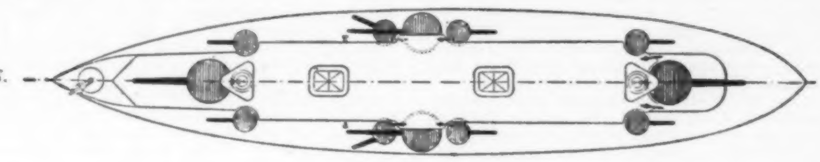


FIG. 18.

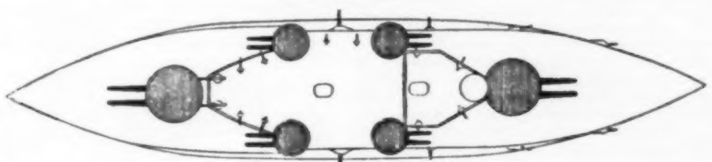


FIG. 19.

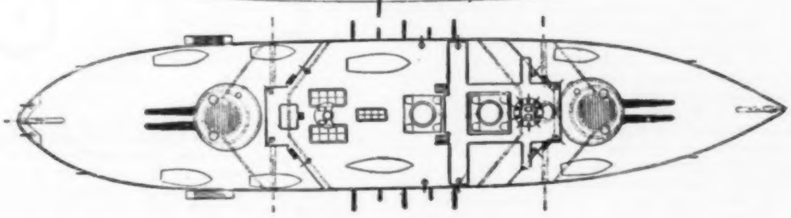
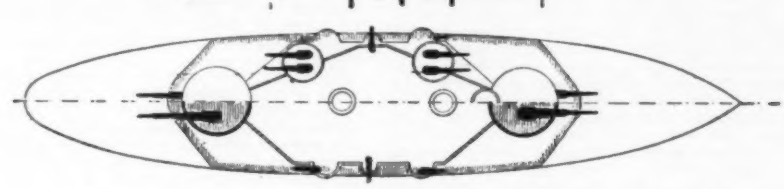


FIG. 20.



FIGS. 17 TO 20.—ARRANGEMENT OF THE ARTILLERY UPON A FIRST-CLASS ARMOR-CLAD.

FIG. 17.—The "Carnot" (French). FIG. 18.—The "Iowa" (American). FIG. 19.—The "Sissoi-Velikry" (Russian). FIG. 20.—The "Oregon" (American).

FIG. 17.—Arrangement of turrets, one at each extremity and one at each side, and each containing but one gun. This arrangement, which is employed on most of the French armor-clads, permits of obtaining a direct fire ahead from three guns, a direct fire aft from three, and a broadside from three. The guns at the side fire over the small turrets containing the artillery of medium caliber. From these turrets may be fired four shots ahead, four aft, and four broadside.

FIGS. 18, 19, AND 20.—Double turrets at the extremities, each containing two large guns. Arrangement adopted in the English, American, and most other navies. It permits of firing only two guns ahead and aft, but four broadside. In Fig. 17 the medium sized guns are in simple turrets placed at the side of the large turrets. In Fig. 18 the medium sized pieces are in pairs in four turrets sponsoned at the angles of the citadel, and the small calibers are within the latter. In Fig. 19 all the medium sized artillery is in the citadel or in casemates. In Fig. 20 four medium sized pieces are in two turrets on the port side. The others, of smaller caliber, are in bastions or sponsons.

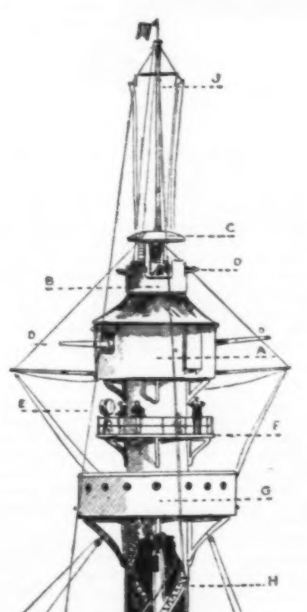


FIG. 21.—MILITARY MAST WITH FIGHTING TOPS.

A. Protected lower top containing rapid-firers of small caliber. The parapet is 75 feet above water and permits of a very efficacious plunging fire being obtained. B. Protected upper top containing machine guns. C. Cupola of the upper top. D. Chase of the guns. E. Electric searchlight, and F. its balcony. G. Station of observation. I. Projectile hoist. J. Mast for signals.

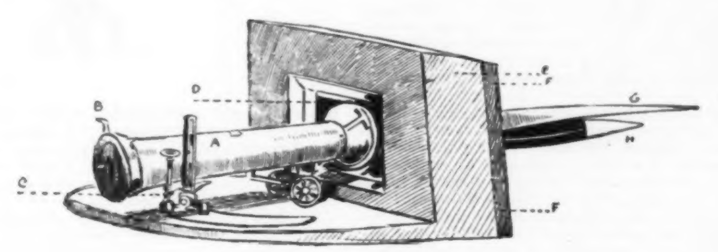


FIG. 22.—TORPEDO TUBE.

A. Body of the tube. B. Breech of the tube. C. Apparatus for pointing. D. Porthole for the passage of the tube. E. Hull of the ship. F. Armor plate. G. Spoon. H. Torpedo at the moment of leaving the tube.

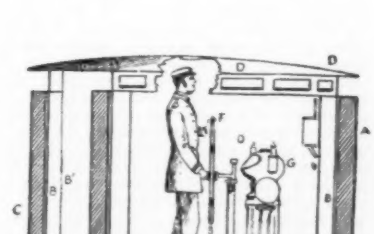


FIG. 23.—CONNING TOWER.

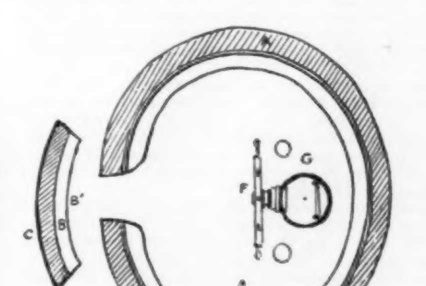


FIG. 24.—PLAN OF THE SAME.

A. Thick armoring. B and B′. Plates and metallic frame supporting the armor plate. C. Shield to protect the entrance. D. Cupola. E. Armored tube for the passage of the wires and speaking tubes for transmitting orders. F. Rudder wheel. G. Compass and apparatus for transmitting orders.

continuously upon deck to direct the fighting, was not assured, at least to as great an extent as possible. The conning tower in which he is stationed is situated in the forward part of the ship, and contains the manipulator of the servo-motor and rudder, the compass, the transmitter of orders communicating with the engines and different fighting stations, the electric manipulator of the signal lights, the telephone apparatus, the speaking trumpets, an apparatus for electrically registering the motions of the rudder wheel, and, in a word, all the apparatus for giving orders. In former times, the conning tower was but slightly armored by means of a few plates, but the progress of rapid-firers has rendered such protection illusory. It is now provided with steel armor which generally reaches a thickness of from 12 to 14 inches in the English navy and from 9 to 11 inches in other navies. It is covered with an iron plate roof to protect it against fire from military tops, and rests upon a frame of iron plate. The armored tube descending to the armored deck protects the parts through which orders are transmitted. Upon certain armor-clads, a second conning tower not so strongly armored is placed aft (Figs. 23 and 24).

The length of a first-class armor-clad is, upon an average, from 335 to 395 feet, its beam about 65, and its draught from 23 to 30. Certain of them measure 75 feet in height from the bottom of the hold to the commander's bridge. They weigh from 11,000 to 12,000 tons, and some, such as the most recent English and largest Italian armor-clads, even exceed 15,000 tons. They carry 2,000 tons of coal, which is stowed in bunkers alongside of the engines and boilers, and which through its thickness forms an armor and adds to the protection of the sides. Their radius of action varies from 4,000 to 10,000 miles. As a general thing English ships have a wider radius of action than those of other countries. In England they cost nine hundred thousand pounds. The French armor-clads, it is true, are better and more carefully finished and have more complicated arrangements, and this has caused the English to style them "maritime palaces."

In order to move such colossi and give them speeds of 17 and 18½ knots, engines of exceptional power are necessary. These are generally double and triple expansion ones that drive two screws. Their power, nominally 11,000 or 12,000 horse, reaches 15,000 horse power upon the last English models, and 18,000 horse power upon the "Italia." The steam is furnished by eight boilers divided into four compartments and heated by thirty-two furnaces. These boilers, upon modern ships, are water-tube ones of the improved Belleville, Niclausse, and other systems, which, among other advantages, permit of being put rapidly under pressure, and which, with less weight, give more steam.

The armor-clad has been the subject of criticism of different natures, viz., that it is not swift enough, that its radius of action is too limited, that it costs too much to construct, and that the services that it is capable of rendering may be rendered just as well by an armored cruiser of lower net cost, and that a torpedo boat that costs two or three thousand francs to construct can destroy it in an instant. This latter argument had its value when artillery did not possess the power that it has at present acquired; but, thanks to the progress in rapid-fire armament, the armor-clad can defend itself victoriously against an attack of torpedo boats, which it would sink in half a minute if they should take the risk of approaching it in the daytime. This has been proved in front of Santiago, where the Spanish torpedo boats were reduced to impotency. At night the armor-clad defends itself with its nets and searchlights and takes refuge upon the high seas, whither torpedo boats could not follow it without danger.

Some nautical men, Admiral Fournier among others, have proposed to replace our fleet of armor-clads by a hundred armored cruisers of the "Dupuy de Lome" type, the protection of which consists of an armor of steel of 4 or 6-inch thickness covering the entire hull. They hold that a squadron of such cruisers would be able to give battle to a squadron of the present armor-clads in utilizing its superior speed, so as to receive all the projectiles obliquely without the armor being perforated. Others of less radical opinion claim that the armoring is useless, and that the belt of cellular compartments and the armored deck would suffice for the protection. Despite such opinion, we have preserved our armor-clads and are constructing new ones, and that rightly, too, since it is a demonstrated fact that the only ship of war capable of giving battle to an armor-clad with any chance of success is another armor-clad.

Nevertheless, something has been done in the order of ideas emitted by Admiral Fournier, and by others before and after him. There is now a tendency in navies to diminish the thickness of the armored belt, in order to lighten the ship, and consequently to increase its artillery, its speed, or its radius of action in taking aboard more coal.

Great speeds, however, do not suffice to give victory. They cannot even shield a fleet in flight from destruction, as was proved by the naval battle of Santiago, which was a triumph for the armor-clad.

Perhaps, the progress of industry aiding, we shall succeed in a near future in obtaining a ship of war uniting with invulnerable armor and powerful artillery the maximum of speed and radius of action.—Clement Casciani, in Le Monde Moderne.

[Continued from SUPPLEMENT, No. 1248, page 20008.]

MAGNETO-OPTIC ROTATION AND ITS EXPLANATION BY A GYROSTATIC SYSTEM.*

I MUST now endeavor to give some slight account of the theories that have been put forward in explanation of magneto-optic rotation. There is an essential distinction between it and what is sometimes called the natural rotation, the plane of polarized light produced by substances, such as solutions of sugar, tartaric acid, quartz, etc., some of which rotate the plane to the right, some to the left. When light is sent once along a column of any of those substances without any magnetic field, its plane of rotation is rotated just as it is in heavy glass or bisulphide of carbon in a magnetic field. But if the ray, after passing through the column of sugar or quartz, is received on a silvered reflector and sent back again through the column to the starting point, its plane of polarization is found to be in the same direction as at first. Quite the contrary happens when the rotation is due to the action of a magnetic field. Then the rotation is found to be doubled by the forward and backward passage, and it can be increased to any required degree by sending the ray backward and forward through the substance, as shown in this other diagram (Fig. 8).

Thus the rotations in the two cases are essentially different, and must be brought about by different causes. In fact, as was first, I believe, shown by Lord Kelvin, the annulment of the turning in quartz, and the reinforcement of the turning in a magnetic field, produced by sending the ray back again after reflection at the surface of an optically denser medium, points to a peculiarity of structure of the medium as the cause of the turning of the plane of polarization in sugar solutions and quartz, and to the existence of rotation in the medium as the cause of the turning in a magnetic field. Think of an elastic solid, highly incompressible and endowed with great elasticity of shape and of the same quality in different directions —a stiff jelly may be taken as an example to fix the

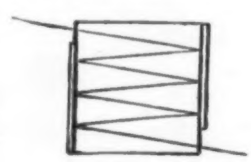


FIG. 8.

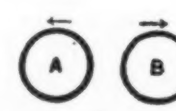


FIG. 9.

ideas. Now let one portion of the jelly have bored into it a very large number of extremely small corkscrew-shaped cavities, having their axes all turned in the same direction. Let another portion have embedded in it a very large number of extremely small rotating bodies, spinning-tops or gyrostats in fact, and let these be uniformly distributed through the substance, and have their axes all turned in the same direction.

Both portions would transmit a plane-polarized wave of transverse vibration traveling in the direction of the axes of the cavities or of the tops with rotation of the plane of polarization; but in the former case the wave, if reflected and made to travel back, would have the original plane of polarization restored; in the latter the turning would be doubled by the backward passage.

To understand this it is necessary to enter a little in detail into the analysis of the nature of plane polarized light. As I have already said, the elastic solid theory may not express the facts of light propagation, but only a certain correspondence with the facts. But its use puts this matter in a very clear way. In a ray of plane


FIG. 11.

polarized light each portion of the ether has a motion of vibration in a line at right angles to the ray, and the direction of this line is the same for each moving particle. The lines of motion and the relative positions of the particles in a wave are shown in the first diagram (Fig. 1). As the motion is kept up at the place of excitation, it is propagated out by the elastic resistance of the medium to displacement, and the configuration of particles travels outward with the speed of light, traversing a wave length (represented in the diagram by the distance between two particles of the row in the same phase of motion) in the period of complete to-and-fro motion of a particle in its rectilineal path.

Now, a to-and-fro motion such as this can be conceived as made up of two opposite uniform and equal circular motions. Think of two distinct particles moving in the two equal circles, *A B*, in this diagram (Fig. 9) with equal uniform speeds in opposite directions. Let each particle be at the top of its circle at the same instant; then at any other instant they will be in similar positions, but one on the right, the other on the left of the vertical diameter of the circle. Thus at that instant each particle is moving downward or upward at the same speed, while with whatever speed one is moving to the left, the other is moving with precisely that speed toward the right. Imagine now these two motions to be united in a single particle. The vertical motions will be added together, the right and left motions will cancel one another, and the particle will have a motion of vibration in the vertical direction of range equal to twice the diameter of the circles, and in the period of the circular motions.

The rate of increase of velocity of the particle at each instant is the resultant obtained by properly adding together the accelerations of the particles in the circular motions, and therefore the force which must act on the particle to cause it to describe the vibratory motion just described is the resultant of the forces required to give to the two particles the circular motions which have just been considered.

Now, what we have done for any one particle may be conceived of as done for all the particles in a wave. To understand the nature of a wave in this scheme, we must think of a series of particles originally in a straight line in the direction of propagation of the ray, as displaced to positions on a helix surrounding that direction. Fig. *A* of this diagram (Fig. 10) regarded from the lower end, and the black spots on the model before you, show a left-handed helical arrangement. Let these particles be projected with equal speeds in the circular paths represented by the circle at the bottom of Fig. *A*. On this circle are seen the apparent positions of different particles in the helical arrangement when it is viewed by an eye looking upward along its axis. This motion is shown by that of the black spots on the surface of the model (Fig. 11), when I set it into rotation about its axis. Let the particles be constrained to continue in motion exactly in this manner. As the model shows, the helical arrangement of the particles is displaced along the cylinder. This is the mode of propagation of a circularly polarized wave, which is made up of helical arrangements of particles which were formerly in straight lines parallel to the axis.

The direction of propagation of the wave is clearly from the bottom of the diagram to the top, and from the end of the model toward your left to the other, when the particles have a right-handed motion, and is in

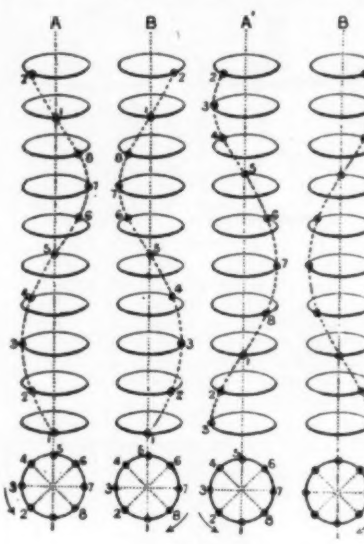


FIG. 10.

the contrary direction when the direction of rotation is reversed. For a right-handed helical arrangement the direction of propagation for the same direction of motion of the particles is the opposite of that just specified. The direction of propagation remains, therefore, the same when the direction of motion and the helical arrangement of the particles are both reversed. All this can be made out from the diagram. Fig. B shows part of a right-handed arrangement of particles corresponding to the opposite arrangement of Fig. *A*; and if the particles have the motion shown at the bottom of the diagram, the propagation will be for both in the same direction, from the bottom to the top.

In Fig. 10 we suppose the periods equal and also the wave lengths, the distance along the axis from particle 1 to particle 9. The combination of the circular motions, *A* and *B*, gives rectilinear motion; the combinations of the wave motions of Figs. *A* and *B* gives a plane polarized wave, the plane of polarization of which does not change in position. If, however, while the periods were equal, the wave lengths were unequal, as shown in this other diagram (Fig. 12), the

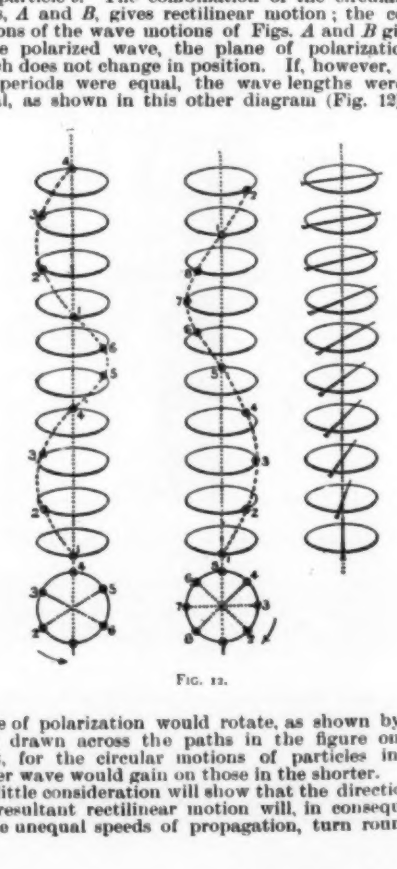


FIG. 12.

plane of polarization would rotate, as shown by the lines drawn across the paths in the figure on the right, for the circular motions of particles in the longer wave would gain on those in the shorter.

A little consideration will show that the direction of the resultant rectilinear motion will, in consequence of the unequal speeds of propagation, turn round a

* A discourse delivered at the Royal Institution by Prof. Andrew Gray, F.R.S.

the wave advances, and will do so in the direction of motion of the particles in the more quickly traveling wave, generating the screw surface shown in the model I have already exhibited.

We must now consider the forces. The particles moving in the circular paths have accelerations toward the centers of these paths, and forces must be applied to them to produce these accelerations. These forces are applied in the present theory by the action of the medium, and it is the reactions of the particles on the medium that are properly called the centrifugal forces of the particles. The requisite centerward forces then are supplied by the state of strain into which the medium is thrown by the displacement of parts of it, which form in the undisturbed position a series of straight arrays in the direction of propagation, into these helical arrangements round that direction. The greater these elastic forces, the greater the velocity of propagation of the wave.

In an elastic medium these forces depend on the amount of the relative displacements of the particles, and will be greater for displacements in the right-hand helical arrangement than for displacements in the opposite direction if the medium has a greater rigidity for right-handed distortion than for left, and the right-handed wave of distortion will be transmitted with greater speed, and vice versa. This is the case of solutions of sugar and tartaric acid, quartz, etc., for which a helical structure has been supposed to exist in the medium.

Taking this case, refer to Figs. *A* and *B* of our large diagram (Fig. 10), and let the right-handed wave travel the faster. Let the waves travel up, be reflected at the upper ends, as at the surface of a denser medium, and then travel down again. The reflected waves are those shown in Figs. *A'*, *B'* of the diagram. By the reflection, the helical arrangement will be unaltered. But the plane of polarization, as we have seen, turns round in space in the direction of the motion of the particles in the more quickly moving wave; it therefore turns round in the direction of the hands of a watch as the wave moves in the upward direction in the diagram, and in the opposite direction when the wave is traveling back. Thus the rotation of the plane of polarization produced in the forward passage is undone in the backward.

It is easy to see that the same thing will take place if the reflection is at the surface of an optically rarer medium, so that the direction of motion of the particles is the same in the reflected as in the direct wave. The helical arrangements, however, are reversed by the reflection, and hence the wave which traveled the more quickly forward travels the more slowly back, and again the turning of the plane of polarization is annuled by the backward passage. Thus Lord Kelvin's hypothesis of difference of structure completely explains the phenomena.

We pass now to the other case, that of magneto-optic rotation. Let us suppose, to fix the ideas, that the right-handed circular ray travels faster than the other, and that whether direct or reversed. Here, as in the other case, the elastic reaction of the medium on the displaced particles depends only on the distortion, and if there be no structural peculiarity in the medium there must be the same reaction in the particles in both the circular waves which combine to make up the plane polarized one.

Thus the actions on the particles being the same for both waves, and the velocities of propagation being different, the motions concerned in the light propagation cannot be the same. There must in fact be a motion already existing in the medium which, compounded with the motions concerned in light propagation, give two motions which give equal reactions in the medium against the equal elastic forces, applied to the particles in the case of equal helical displacements.

Thus Lord Kelvin supposes that in the medium in the magnetic field there exists a motion capable of being compounded with the luminiferous motion of either circularly polarized beam. The latter is thus only a component of the whole motion.

In the very important paper in which he has set forth his theory Lord Kelvin expresses his strong conviction that his dynamical explanation is the only possible one. If this view be correct, Faraday's magneto-optic discovery affords a demonstration of the reality of Ampere's theory of the ultimate nature of magnetism. For we have only to consider the particles of a magnetized body as electrons or groups of charges of electricity, ultimate as to smallness, rotating about axes on the whole in alignment along the direction of the magnetic force, and with a preponderance of one of the two directions of rotation over the other. Each rotating molecule is an infinitesimal electro-magnet, of which the current distribution is furnished by the system of convection currents constituted by the moving charges.

The subject of magneto-optic rotation has also been considered by Larmor, and two types of theory of these effects have been indicated by him in his report on the "Action of Magnetism on Light." One is represented by Lord Kelvin's theory, which is illustrated by Maxwell's chapter on molecular vortices in his "Electricity and Magnetism." Fitzgerald's paper "On the Electromagnetic Theory of the Reflection and Refraction of Light," in the Philosophical Transactions for 1880, is related to Maxwell's theory, and explains the rotation produced by reflection from the pole of a magnet by means of the addition of a term to the energy of the system. The other theory is also a purely electromagnetic one, and supposes that the effects are due to a kind of æolotropy of the medium set up by the magnetization, and so attributes them to a change of structure which introduces rotational terms into the equations connecting electric displacements and electric forces. This latter theory, therefore, regards the magneto-optic rotation as only a secondary effect of the magnetization, which is not supposed to exert any direct dynamical influence on the transmission of the light-waves.

It is not possible here to enter into the subject of these theories, but I should like to direct attention to a paper by Mr. J. G. Leathem, published in the Philosophical Transactions, in which the type of theory just referred to has been worked out and compared in its results with the experiments of Sissingh and Zeeman in reflection. These investigators made measurements of the phase and amplitude of the magneto-optic component of the reflected light for various angles of incidence. For both these quantities the theoretical results of Leathem agree very well with the observed values.

Returning now to the gyrostatic medium, between which and the electromagnetic theory, it is to be remembered, there is a correspondence, we may inquire in what way the gyrostats, when moved by the vibrations of the medium, react upon it, and so affect the velocity of propagation. The motion of a gyrostat is often regarded as mysterious, and it can hardly be fully explained except by mathematical investigation. But the general nature of its action may be made out without much difficulty. First of all, a gyrostat consists of a massive fly-wheel running on bearings attached to a case which more or less completely incloses the wheel. The mass of the wheel consists in the main of a massive rim, which renders as great as possible what is called the moment of momentum of the wheel when rotating about its axis. The diagram (Fig. 13)

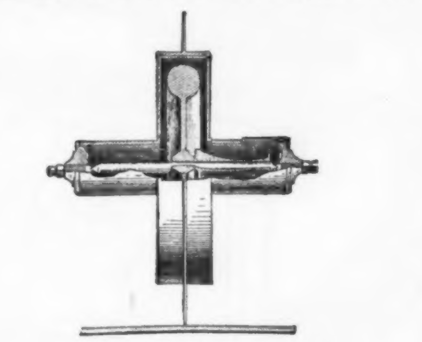


FIG. 13.

represents a partial section of the case and fly-wheel of a gyrostat, showing the arrangement of fly-wheels and bearings.

Now let the fly-wheel of such a gyrostat be rapidly rotated, and the gyrostat be hung up as shown in this other diagram (Fig. 14), with the plane of the fly-wheel vertical, and a weight attached to one extremity of the axis. The gyrostat is not tilted over, but begins to turn round the cord by which it is suspended with a slow, angular motion, which is in the direction of the horizontal arrow, if the direction of rotation is that of

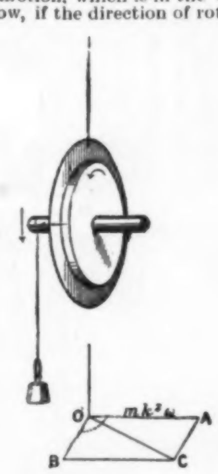


FIG. 14

the circular arrow shown on the case. The same thing is shown by the experiment I now make. I spin this gyrostat and hang it with the axis of rotation horizontal by passing a loop of cord round one end of the axis so that the weight of the gyrostat itself forms the weight tending to tilt it over about the point of suspension. The axis of rotation here again remains nearly horizontal, but turns slowly round in a horizontal plane as before.

The explanation in general terms is this: The weight gives a couple tending to turn the gyrostat about a horizontal axis at right angles to that of rotation. This couple in any short interval of time produces moment of momentum about the axis specified, the amount of which is the moment of the couple multiplied by the time, and may be represented in direction and magnitude by the line, *OB*. This must be compounded with the moment of momentum, *OA*, already existing about the axis of rotation, and gives for the resultant moment of momentum the line, *OC*, which is the direction of the axis of rotation after the lapse of the short interval of time. The axis of rotation thus turns slowly round in the horizontal plane, and the more slowly, the more rapidly the fly-wheel rotates.

The gyrostat, in fact, must have this precessional motion, as it is sometimes called, in order that the moment of momentum of the gyrostat about a vertical axis may remain zero. That it must remain zero follows from the fact that there is no couple in a horizontal plane acting on the gyrostat.

Thus any couple tending to change the direction of the axis in any plane produces a turning in a perpendicular plane. For example, if a horizontal couple, that is about a vertical axis, were applied to the axis of the gyrostat in the last figure, it would turn about a horizontal axis, that is, would tilt over.

Again, consider a massive fly-wheel mounted on board ship on a horizontal axis in the direction across the ship. The rolling of the ship changes the direction of the axis, and produces a couple applied by the fly-wheel to the bearings and an equal and opposite couple applied by the bearings to the fly-wheel. This couple is in the plane of the deck, and is reversed with the direction of rolling, and has its greatest value when the rate of turning of the ship is greatest. Thus the force on one bearing is toward the bow of the ship, the force on the other toward the stern, during a roll from one side to the other; and these forces are reversed during the roll back again. This is the gyrostatic couple exerted on its bearings by the armature of a dynamo on shipboard.

In the same way, when a gyrostat is embedded in a medium and the medium is moving so as to change the direction of the axis of rotation, a couple acting on the medium in a plane at right angles to the plane of the direction of motion is brought into play. To fix the ideas, think of a row of small embedded gyrostats along this table with their axes in the direction of the row, and their fly-wheels all rotating in the same direction. Now let a wave of transverse displacement of the medium in the vertical direction pass along the medium in the direction of the chain. The vibratory motion of each part of the medium will turn the gyrostatic axis from the horizontal, and thereby introduce horizontal reactions on the medium. Again, a wave of horizontal vibratory motion will introduce vertical reactions in the medium from the gyrostats.

Now, a wave of circular vibrations, like those we have already considered, passing through the medium in the direction of the chain, could be resolved into two waves of rectilinear vibration, one in which the vibration is horizontal, and another in which the vibration is vertical, giving respectively vertical and horizontal reactions in the medium. The magnetization of the medium is regarded as due to the distribution throughout it of a multitude of rotating molecules, so small that the medium, notwithstanding their presence, seems of uniform quality. The molecules have, on the whole, an alignment of their axes in the direction of magnetization. These reactions on the medium when worked out give terms in the equations of wave propagation of the proper kind to represent magneto-optic rotation.

It is worthy of mention that the addition of such terms to the equation was made by McCullagh, the well-known Irish mathematician, who, however, was unable to account for them by any physical theory. The necessary physical theory may be regarded as afforded by the mechanism which thus forms an essential part of Lord Kelvin's mode of accounting for magneto-optic effects.

Lord Kelvin, in his Baltimore lectures, has suggested for magneto-optic rotation a form of gyrostatic molecule consisting, as shown in the figure, of a spherical sheath inclosing two equal gyrostats. These are connected with each other and with the case by ball-and-socket joints at the extremities of their axes, as shown in Fig. 15. If the spherical case were turned round

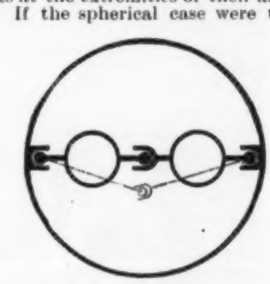


FIG. 15.

any axis through the center, no disalignment of the gyrostats contained in it would take place, and it would act just like a simple gyrostat. If, however, the case were to undergo translation in any direction except along the axis, the gyrostats would lag behind, and the two-link chain which they form would bend at the center. This bending would be resisted by the quasi-rigidity of the chain produced by the rotation, and the gyrostats would react on the sheath at the joints with forces as before at right angles to the plane in which the change of direction of the axis takes place.

The general result is, that if the center of this molecule be carried with uniform velocity in a circle in a plane at right angles to the line of axes, the force required for the acceleration toward the center, and which is applied to it by the medium, is greater or less according as the direction in which the molecule is carried round is with or against the direction of rotation of the gyrostats. That is, the effect of the rotation is to virtually increase the inertia of the molecule in the one case and diminish it in the other.

These molecules embedded in the medium are supposed to be exceedingly small, and to be so distributed that the medium may, in the consideration of light propagation, be regarded as of uniform quality. Lord

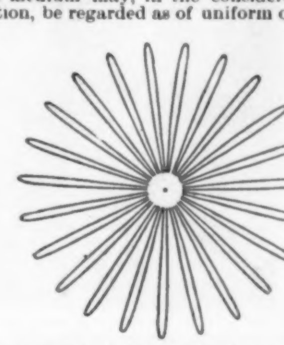


Fig. 16.—Path of the Bob of a Gyrostatic Pendulum. As the pendulum moves, it passes from one ray to another on the opposite side, and the direction of motion at each swing alters through the angle between two rays. The central parts of the rays are left out. The marking point does not pass exactly through the center.

Kelvin's last form of molecule, it may be pointed out, if the surface of its sheath adheres to the medium, will have efficiency as an ordinary single gyrostat as regards rotations of the molecule, and efficiency likewise as regards translational motion of the center of the molecule. The former efficiency can be made as small as may be desired by making the molecule sufficiently small; the latter may be maintained at the same value under certain conditions, however small the molecule be made.

The lately discovered effect of a magnetic field in giv-

ing one period of circular oscillation of a particle or another according as the particle is revolving in one direction or the other about the direction of the magnetic force, is connected with magneto-optic rotation. There is a connection between velocity of propagation and frequency of vibration, which is exemplified by the phenomena of dispersion. In the Faraday effect, the two modes of vibration, if of the same period, have different velocities of vibration, consequently these two modes of vibration must have different frequencies for the same velocity of propagation.

The vibrations of the molecules of a gas in which the Zeeman effect is produced by a magnetic field may be represented by the motion of a pendulum the bob of which contains a rapidly rotating gyrostat with its axis in the direction of the supporting wire of the pendulum. The period of revolution of the bob when moving as a conical pendulum is greater or less than the period when the gyrostat is not spinning according as the direction of revolution is against or with the direction of rotation.

The bob when deflected and let go moves in a path which constantly changes its direction, so that if a point attached to the bob writes the path on a piece of paper, a star-shaped figure is obtained. I cause the gyrostatic pendulum here suspended to draw its path by a stream of white sand on the blackboard placed below it, and you see the result.

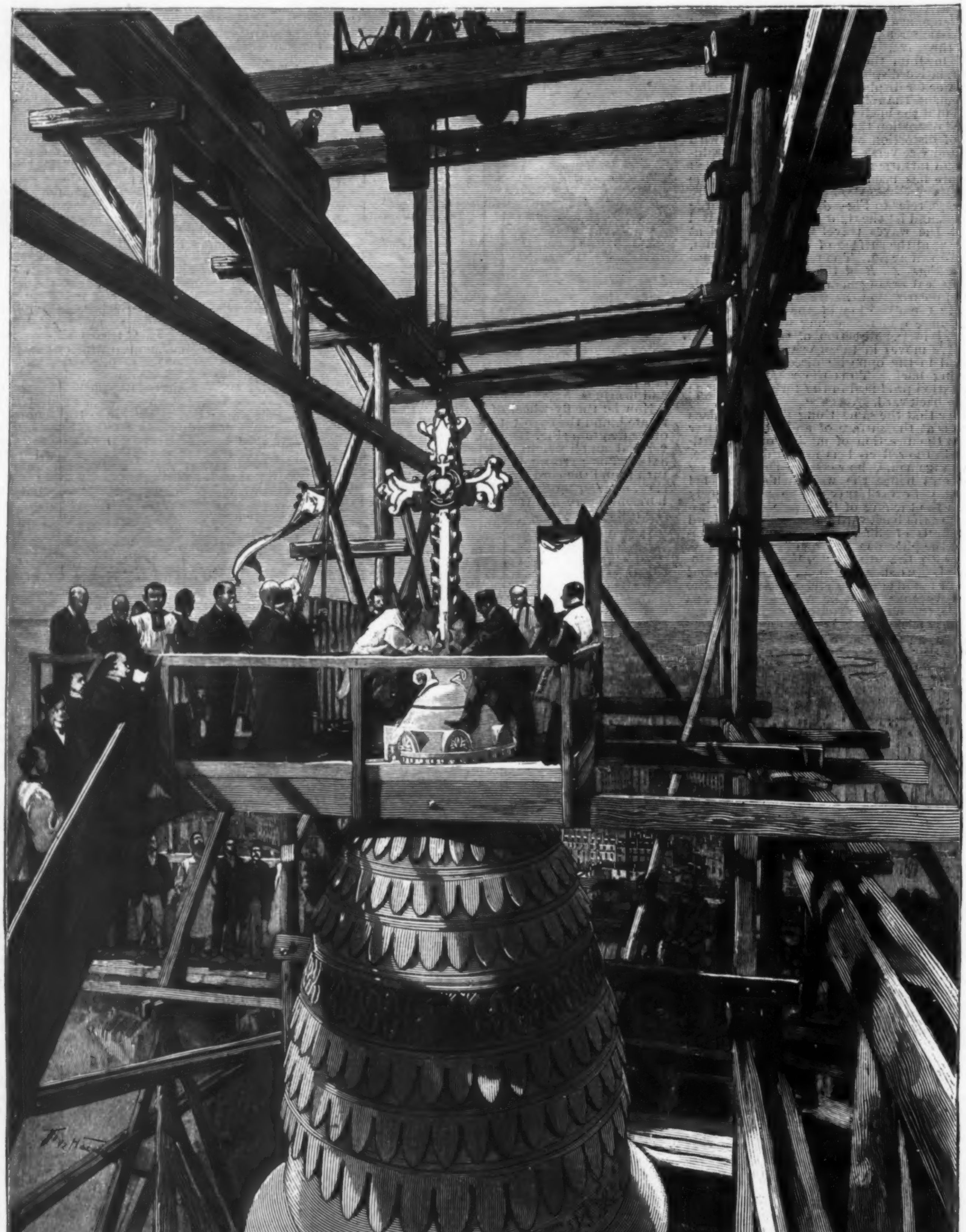
I must here leave the subject, and may venture to express the hope that on some other occasion some one more specially acquainted with the electromagnetic aspects of the phenomenon may be induced to place the latest results of that theory before you.

THE CROSS OF THE BASILICA OF THE SACRED HEART.

THE cross surmounting the central dome of the basilica of the Sacred Heart at Montmartre was placed in position on Tuesday, October 17. This cross, which was hewn in a single piece from a block of Corgoloin lias stone, measures 3·75 feet in its transverse part, 10·33 feet in total height and 9·33 feet in visible height—one foot at the base being reserved for holding it in position in the cavity prepared for its reception. It contains 1,918 solid feet of material and weighs 3,740 pounds. The decorative motives consist of trefoils; and at the intersection of the arms there stands out in relief a heart crowned with thorns. The cross was hoisted on Monday by means of a rolling crane, which, moving over a floor established upon scaffoldings, brought it just above the lantern where it was to be erected. This operation was, on the following day, the occasion of a very curious and imposing ceremony.

The Cardinal-Archbishop of Paris had expressed the intention of presiding in person at the crowning of the work, in which he had particulary interested himself, and, despite his great age, he would not consent that such presidency should be exercised from below. Hence a question of a practical nature arose: How was Monsignor to ascend to a height of 269 feet? The infliction upon his octogenarian legs of the drudgery of climbing the five hundred or more steps of the scaffolding stairway was not to be thought of. But M. Rauline, the able successor of Architect Abadie, is accustomed to meeting with problems just as difficult, and was therefore equal to the occasion in solving this one. This is how it was possible, on Tuesday, on a beautiful autumn afternoon, for the processional ascension of the clergy, the benefactors of the church and fifty invited guests to be made in the huge wooden cage. His Eminence, Cardinal Richard, took his seat in a sedan chair provided with a frame covered with an awning of white lawn striped with blue (the pontifical colors), in order to conceal the vacuity from the prelate's eyes. While four robust carpenters carried him, a play of light occasionally displayed his outlines. With him slowly ascended the pious file, in which was remarked General De Charette firmly holding his famous standard aloft.

The invited guests halted and massed themselves at the last landing. The Archbishop, the officiating clergy,



PLACING THE CROSS IN POSITION ON THE DOME OF THE BASILICA OF THE SACRED HEART, AT MONTMARTRE.

the architect and his assistants and a few privileged persons alone mounted still higher by a steep stairway erected over the dome and leading to a small platform arranged at the summit of the lantern. At the balustrade a tricolored flag was hoisted; and then arose chants, accompanied with flourishes of trumpets, repeated by the assistants, and followed by a solemn silence. The cross balanced itself for an instant over the cavity that was to receive its base, and the crane then allowed it gently to descend. The chants and flourishes of trumpets were heard again; and, from a cloud of incense, came forth, mitered and coped, a grand old man, bent and trembling, who pronounced the benediction.

For the above particulars and the engraving, we are indebted to L'Illustration.

MOTOBICYCLES.

The bicycle provided with a gasoline motor has already shown what it is capable of doing, and has exhibited qualities that assure it a favorable future. It having been found that this mechanically operated vehicle presents peculiar and indisputable advantages, several manufacturers have devoted themselves to a study of the best arrangements to give it, and at the last Automobile Exhibition there were shown several new styles that we purpose to describe. The contest recently organized by the Velo between automobile bicycles had the effect of bringing such apparatus into some prominence. In this contest, which took place between Etampes and Chartres, through Ablis, and return (say a distance of 60 miles), seven systems were to have been represented—the Werner, Durey, Phebus, Pernoo, Bustarret, Garreau and Lamaudiere and Labre; but the Bustarret and Phebus did not put in an appearance.

In consequence of accidents on the way, the Durey and Lamaudiere and Labre machines were thrown out of the race, and the contest was narrowed down to a race between the Werner machines, four specimens of which reached the goal, although they were distanced by the Pernoo bicycle, ridden by the racer Labitte. The speed of the Victor did not exceed 22 miles an hour, and that of the Werner machines 15 miles, although their riders pedaled almost continually. It may therefore be concluded from this that the motor furnished but an inconsiderable aid, since such speeds could have been easily attained and exceeded by ordinary bicycles operated by the legs and ridden by racers of some little training.

It is certainly unfortunate that the other competitors were arrested almost at the beginning, since the results would otherwise have been different from what they turned out to be. It is therefore to be hoped that the challenge offered to the victors by MM. Durey and Lamaudiere and Labre will be accepted, so that the machines of these manufacturers may again be seen in a contest.

Meanwhile we shall describe some automobile bicycles, and more particularly the Lamaudiere and Labre motobicycle, which appears to us to combine all the qualities that can be asked for in an apparatus of this kind, and which, in our opinion, constitutes the most improved system that has so far appeared.

This machine, as shown in Fig. 3, presents a really elegant appearance. It preserves all the proportions of an ordinary bicycle, and the motor, carbureter and accessories are of reduced size and placed within the frame. The motor is arranged in the axis of the central tube of the frame, and even replaces it for a certain length. Its cylinder, provided with cooling ribs, is of 2·6 inches internal diameter. The normal velocity is 2,000 revolutions per minute and the power developed is about 650 foot pounds per second. Finally, the whole does not exceed 17 pounds in weight. The operation of the motor is effected in four periods. The regulating flywheel, instead of being incased, revolves freely on the exterior. The lubrication is done automatically, and the escapement valve is actuated by a new and very ingenious method that does away with intermediate gearings. The carbureter consists of a metallic box divided into two compartments, one of which serves as a reservoir and the other as a carbureter properly so called. In this latter, some plates arranged vertically at the lower part of the box limit the agitation of the liquid during the operation of the machine, and there is thus obtained a uniform carburation, whatever be the extent of the jolting and vibration on the road.

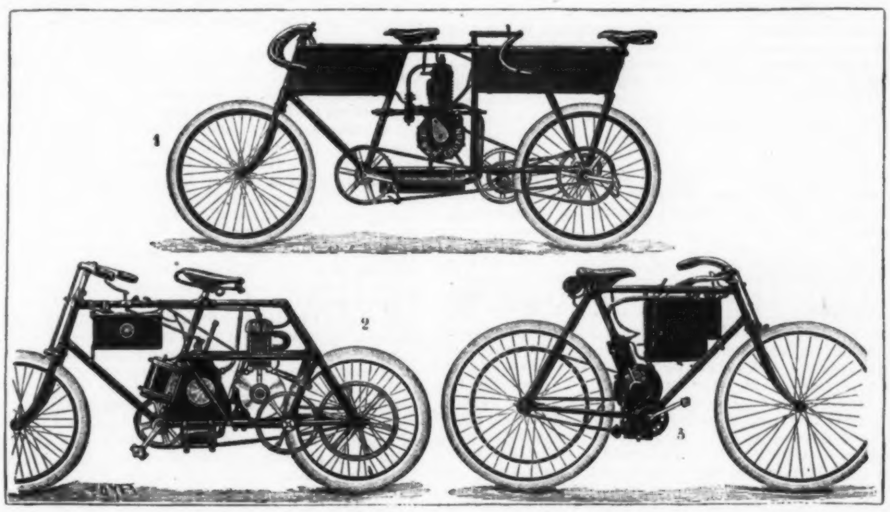


Fig 1.—THE RICHARD-CHOUBERSKY AUTOMOBILE TANDEM. Fig. 2.—MECHANISM OF THE GIRARDOT BICYCLE. Fig. 3.—THE LAMAUDIERE AND LABRE GASOLINE BICYCLE.

The transmission of motion to the hind wheel is effected through a leather belt passing over pulleys of unequal diameter and the larger of which is fixed directly upon the spokes of the driving wheel. The belt passes between the two arms of a slider designed to guide the axis of a stretching pulley which the cyclist may operate by means of a lever provided with a click and jointed to the upper tube of the frame. By this means, it is therefore possible to disconnect the motor instantaneously and render it independent of the bicycle. The ignition is effected through an electric spark, the production of which is regulated by a cam without a vibrator. The current is furnished by a small accumulator attached to the frame in front of the carbureter, and which actuates an induction coil fixed behind the saddle.

This automobile bicycle is the lightest one that has appeared up to the present. While all those that have preceded it have an average weight of 110 pounds, the Lamaudiere and Labre machine does not exceed a weight of 65 in running order. With 3 quarts of gasoline in its reservoir, it permits of making a trip of 60 miles. It is, therefore, from every point of view, the most practical and economical motocycle in existence; and since its running is perfect, as has been shown by a prolonged experiment upon the road, its success is assured with all those who like light and cheap automobiles.

The last automobile exhibition showed us several other systems of motocycles due to MM. Garreau, Girardot, Flinois and the Chapelle Brothers. Figs. 2 and 4 show the aspect of the Girardot machine. As for the two last, they present no character of originality, and we do not think that they have the least chance of pleasing the public, because of the complication of their mechanism and their imperfect or inconvenient arrangement.

Fig. 5 represents an automobile bicycle for the training of bicycle racers upon a track, and which was devised by M. Albert Boyer. The motor is of the Dion-Bouton 1¾ horse power type, and is arranged vertically above the hind wheel of the bicycle, which is provided with an ordinary sprocket chain. The machine is started by means of pedals, and is geared to 120.

The ignition is effected by electric batteries and a coil, according to the ordinary method, and the total weight of the machine in running order is 155 pounds. The speed attained has, in several cases, exceeded 36 miles an hour.

The training of racers upon a track is tending to give way to training through automobile machines, and in Figs. 1 and 6 may be seen gasoline tandems arranged to this effect. But such machines do not appear to be any more advantageous than the bicycle for this special application. They are heavier and their speed is no greater, by reason of the greater friction that the motor has to overcome; and so we think that the bicycle for one rider possesses more advantages and will, ere long, be master of the road.

Fig. 4.—M. GIRARDOT UPON HIS GASOLINE BICYCLE.

If, now, we desire to draw a conclusion from this brief study, we shall find that but one opinion can force itself upon any person who has closely examined the motocycles of all categories, and that is that the automobile bicycle, rationally constructed, presents undeniable advantages, even over the tricycle now so much in favor. With the motor applied to the crank hanger, the center of gravity becomes lowered and stability is assured to such a degree that, upon even ground, it is possible to abandon the handle bar without danger, just as in an ordinary bicycle. Moreover, since these machines have their two wheels in the same axis, they can move in the narrowest cyclable paths and avoid the pavement, which is something that cannot be done by the tricycle. In case of accident to the motor, the latter can be immediately rendered independent by throwing off the transmission belt, and the rider can then pedal without much fatigue. Finally, it is the motocycle of the public at large, by reason of its relatively low price (which does not reach $200) and especially of its small consumption of gasoline. Most of the defects for which fault was, with good reason, found with the first systems of motobicycles have fortunately been completely suppressed in the most recent models, which are as convenient and advantageous as it is possible for bicycles actuated by the hydrocarbon motor to be.

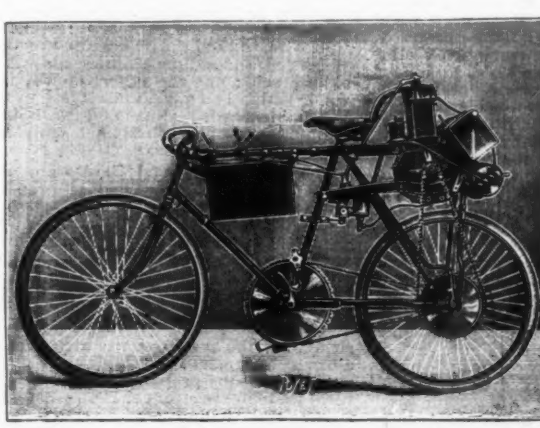


Fig. 5.—BOYER'S BICYCLE FOR TRAINING ON A TRACK.

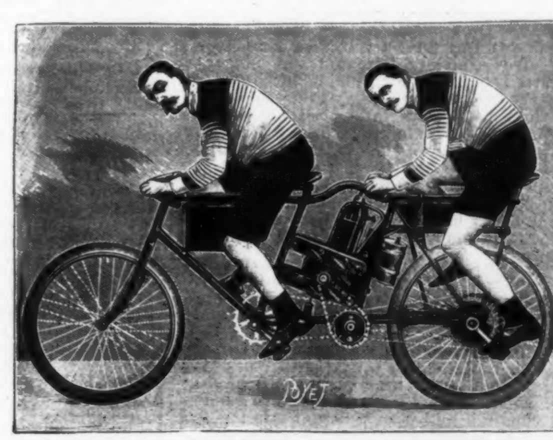


Fig. 6.—MM. COURET AND BOUDIN UPON A GASOLINE TANDEM BICYCLE.

For the above particulars and the engravings, we are indebted to La Nature.

An experiment is being made in the Louvre in bringing figures together which are made up of a variety of colored marbles. The contrasts of color are generally too violent to be pleasing. So very many examples remain that there can be no doubt that at one time multi-colored statues were very popular in Rome. According to The Architect, there is a tendency of late in France to produce polychrome sculpture, and the attempts of modern artists are more satisfactory than the antique precedents.

TRADE NOTES AND RECEIPTS.

Increased Solubility of Rock-Oil in Alcohol.—According to H. Guttmann and Herzfeld & Beer (German patent No. 101,414), 8 to 10 percentum of benzol were added to the alcohol in order to increase the solubility of petroleum to 18–20 per cent. By a further addition of about 4 per cent. of naphthalin it is possible to raise the solubility to 23–24 percentum. Hence this process admits of dissolving almost double the quantity of petroleum in alcohol.—Zeitschrift für Angewandte Chemie.

Coating for Blackboards.—The boards are thinly coated three times with black oil paint. Next grind powdered pumice stone very finely in oil-turpentine and add it to a black, fat paint prepared with good rubbing varnish, making two applications with this. When the last coating has dried and hardened, it is rubbed down with ground pumice stone and water, by means of a felt rag, for half an hour, until it is uniformly dull. Wash off thoroughly and neatly and rub dry with a chamois. One may write not only with chalk, but also with a slate pencil on this coating.—Deutsche Maler Zeitung.

Artificial Bitter Water.—1. Crystallized bitter salt, 1,030 parts; crystallized sodium carbonate, 1,040 parts; potassium sulphate, 5 parts; sodium carbonate, 30 parts; water, 3,000 parts. 2. Potassium sulphate, 5 parts; precipitated calcium sulphate, 30 parts; crystallized bitter salt, 2,500 parts; crystallized sodium sulphate, 1,000 parts; distilled water, 3,000 parts. 3. Sodium sulphate, 1000 parts; bitter salt, 500 parts; sodium bicarbonate, 250 parts; cooking salt, 70 parts; precipitated calcium sulphate, 75 parts; potassium sulphate, 3 parts; crystallized iron sulphate, 7 parts; water, 3,000 parts.—Neueste Erfahrungen and Erfindungen.

Foam Preparations.—A really serviceable recipe for the production of harmless gum cream, says the Suddeutsche Apotheker Zeitung, is the following:

Digest 100·0 of Panama wood for eight days with 400·0 of water and 100·0 of spirits of wine (90 per cent.) Pour off without strong pressure and filter.

For every five kilos of lemonade sirup take 5·0 of this extract, whereby a magnificent, always uniform foam is obtained on the lemonade.

Another receipt is as follows: Heat 200·0 of quillayo bark with distilled water during an hour in a vapor bath, with frequent stirring, and squeeze out. With a mixture of 100·0 of spirits of wine the colature is made to weigh one kilo in all by thinning with water, if necessary, and filter.

Metallic Luster on Pottery.—According to a process patented in Germany, a mixture is prepared from various natural or artificial varieties of ocher, to which 25–50 per cent. of finely powdered more or less metalliferous or sulphurous coal is added. The mass treated in this manner is brought together in seggars with finely divided organic substances such as sawdust, shavings, wood-wool, cut straw, etc., and subjected to feeble red heat. After the heating the material is taken out. The glazings now exhibit that thin but stable metallic color which is governed by the substances used. Besides coal, salts and oxides of silver, cobalt, cadmium, chrome iron, nickel, manganese, copper or zinc may be employed. The color-giving layer is removed by washing or brushing, while the desired color is burned in and remains. In this manner handsome shades can be produced.—Chemiker Zeitung.

French Stove Polish.—The French stove polish which is used for blackening and polishing iron stoves is produced in the following manner:

1.	Turpentine oil, French or American	23·0 kilos.
	American lampblack	3·0 "
	Prime black, fat, finely elutriated graphite	2·5 "
2.	Ceresine	3·0 "
"	Carnauba wax	0·5 "

Melt the ceresine and carnauba wax in a tinned or enameled kettle over a moderate fire and add mixture 1, previously stirred cold, to the fusion, 2, but only at a distance from the fire, with stirring. Pour this mixture through a fine metal sieve into a second vessel, and next, for a more intimate mixture, from one kettle into another until it begins to thicken, and only then fill into tin cans. If the paste should have become a little too cold during the filling of the tins, so that it interferes with the pouring, all that it is necessary is to put the vessel into a larger one containing boiling water, whereby it is rendered more liquid again.—Seifensieder Zeitung.

Low-priced Paint.—A paint for floors, wood or stone, etc., taking the place of oil paints and varnishes is obtained according to Dingler's Polytechnisches Journal in the following manner:

Soak 60 grammes of good pale joiner's glue over night in cold water and dissolve it next with constant stirring in thickish milk of lime prepared from 0·5 kilogramme of fresh caustic lime and heated to a boil. To the boiling glue-lime add with constant stirring as much linseed oil as is bound by saponification, until the oil simply does not mix any more. Too large a quantity of oil is bound by stirring in some fresh lime pulp. About 0·25 kilogramme of oil is required. The cooled thickish, white ground paint may be mixed with any color not altered by lime, thinning with water if necessary. For yellowish brown shades such as "satinober" or for brownish red, about a quarter of the volume of a brown solution obtained by boiling shellac and borax with water may be added with advantage, which is especially suitable for floor coatings. The mixture flows well, has good covering qualities and unites the ground in the most durable manner with the top coating of any description. Since any tints may be produced with suitable pigments, this paint, which takes the finest luster by a simple coating of varnish, may, in many cases, take the place of the much more expensive varnish and oil paints. This coating can be rubbed down by the use of a little linseed oil or oil of turpentine, for the production of smooth surfaces for varnishing. It also adheres to surfaces already covered with old oil paint or varnish, but in that case requires more glue. It can be conveniently mixed with water glass without soon becoming lumpy, and can be readily applied.—Allgemeiner Bau-Anzeiger.

MISCELLANEOUS NOTES.

Arrangements are being made for extending the use of the new Lyddite shell, which has hitherto been confined to the 5-inch howitzer, to guns of higher caliber, and it is now to be supplied to the 9·2-inch guns mounted in the forts of the English sea fronts. The new projectile is made of forged steel with a solid base, and fitted at the nose with a gun metal socket, tapped with a G. S. gage. The 5-inch howitzer is to be permanently supplied with Lyddite shell, and orders have been issued that no more shrapnel shell is to be made for this gun. It has also been officially notified that the quick-firing armor-piercing shell for the 12-pounder 12 cwt. gun is withdrawn from land service, and the present stock in the naval yards will be used for practice.

Comparative fatigue of the eyesight caused by various illuminants.—A Russian physician, Kotz, according to L'Eclairage, gives a simple method of measuring the degree of fatigue occasioned by various artificial illuminants. It is stated as being sufficiently accurate and consists of the number of winks of the eyelid in a given time. In fact, it is shown physiologically that the winking of the eye is produced when the retina or muscles of the eye are fatigued. In using this method upon himself, the author found during a reading of ten minutes that the frequence of winking was as follows:

6·8 winks per minute with a candle.
2·8 " " " " city gas.
2·2 " " " " sunlight.
1·8 " " " " electric light.

These results do not seem to accord with preconceived notions and further experiment and testing would seem desirable.—Progressive Age.

At a meeting of the Society of Engineers, held at the Royal United Service Exhibition, Whitehall, recently, a paper was read by Mr. J. Bridges Lee on "Photographic Surveying." The author set out in detail the special advantages of the photographic method. Among these advantages are: (1) A more complete and accurate record than can be obtained by any other means; (2) saving of time in the field; (3) ability to take full advantage of short clear interludes in unsettled weather; (4) special advantages for military purposes in an enemy's country; (5) utility for travelers traversing a country; (6) usefulness for detecting geological and physiographical changes; (7) economy in operation. The author then passed in review the various kinds of photo-topographic apparatus which had been designed and constructed, pointing out the distinctive features of most of the best known instruments. All the best photographic survey work everywhere had been done with plane projection instruments. The author described the improvements made by him designed to facilitate the subsequent interpretation of the photographs. These improvements consist of certain mechanical appliances inside the camera for securing an automatic record on the face of every picture taken of the horizon and principal vertical lines, of the compass bearing of the optic axis or principal plane, of a scale of horizontal angles applicable to all points visible in the picture, and of memoranda of useful information relating to the particular picture.—Mechanical Engineer.

J. G. Vibert, the famous French painter, has made the chemistry of colors an especial study and has written a book, "La Science de la Peinture," which deals at length with the qualities of different pigments. His book is regarded as an authority by most artists, and some of his statements are consequently of the greatest interest. The ancient painters, he says, of the time of Apelles, had only four colors: Chalk white, yellow ocher, red ocher, and black. In Pliny's time the number had been increased by different kinds of chalk whites, lead white and its combinations, massicot, minium, orpiment (red and yellow sulphuret of arsenic), red and purple lakes (made from shells), natural and burnt ochers, cinnabar, indigo, powdered Emaux blue, verdigris, brown earths, ivory black and other blacks, and sepia. Later came the red lakes, made from cochineal, from certain woods and from madder; yellow lakes, made from "graine d'Avignon" (French berry) and the true ultramarine blue, made by grinding up the costly stone lapis lazuli.

The writer goes on to speak of a chest, now in the museum of Antwerp, which was formerly the property of Rubens, and contains a collection of the colors with which that celebrated painter used to lay his palette. They include most of those mentioned above. In commenting upon the choice of colors by the artists of the time of Rubens, Vibert says it is worth noting which pigments have lasted best. White lead, cinnabar, lapis (ultramarine), the madder lakes, the earths and the ochers have all withstood the years well, but all the vegetable yellows, reds, and greens have faded and become lost, chiefly through the effects of light.

Since Rubens, says the author, many colors have been discovered and invented, unfortunately often more brilliant than lasting. The discovery of aniline as a base for different pigments was, he says, a great misfortune for art. By the use of wax, oil, and aniline it is possible to compound a coloring substance which shall appear excellent, but which, in reality, is largely a sham, the three substances mentioned serving to take the place of the actual pigment, and being greatly inferior to it. The finest colors, in a word, are those composed of nothing but the pure pigment, softened with a small quantity of linseed or poppy oil as a medium. Owing to the tendency of even the purest vegetable oil to become dark, experiments have been made with other mediums, among which petroleum has been used successfully.

Vibert comes to the general conclusion that most of the colors made from vegetable substances are bad because they are destroyed by light and by combination with mineral products. The mineral colors are generally permanent, but it is hard to procure them in a state of perfect purity. The fact that untrustworthy colors are often disguised under various names and that certain pigments are bad if used alone, but harmless and desirable when combined with others, makes it highly advantageous, thinks Vibert, that an artist should understand the chemical properties of his materials and be able to test them for himself.—Pharmaceutical Era.

SELECTED FORMULÆ.

An old method to get rid of cockroaches is both simple and efficient. This is by the use of the common red wafers that may be had at any stationer's, and which are, it seems, a food much esteemed by the insects. They eat them greedily and die from the effects.

To Make Colored Lacquer.—Make a very deep colored solution of any aniline color and methylated spirits. Filter the solution through fine muslin, and to it add brown shellac in flakes in the proportion of 4 to 5 ounces shellac to one pint of spirits. Shake once a day, and in 7 or 8 days it is fit for use. Apply cold with a camel hair brush; two or more coats will generally be found necessary. When dry, the article should be warmed in front of a clear fire for a few seconds, the hotter the better; this will fix the lacquer on firmly. If made too hot, the colors are likely to fade. Aniline brown and green give excellent results. A separate bottle of uncolored lacquer may be kept, made in the above proportions, and by mixing with the colored lacquer any shade can be obtained.—J. Pool, Melpaunka, New South Wales, Australia.

Strengthened Filter Paper.—When ordinary filter paper is dipped into nitric acid (s. g. 1·42), thoroughly washed and dried, it becomes a tissue of remarkable properties, and one that deserves to be better known by chemists and pharmacists. In shrinks somewhat in size and in weight, and gives, on burning, a diminished ash. It yields no nitrogen, nor does it in the slightest manner affect liquids traversing it. It remains perfectly pervious to liquids, its filtering properties being in no wise affected, which, it is needless to say, is very different from the behavior of the same paper "parchmented" by sulphuric acid. It is as supple as a rag, yet may be very roughly handled, even when wet, without tearing or giving way. These qualities make it very valuable for use in filtration under pressure or exhaust. It fits closely to the funnel, upon which it may be used direct, without any supports, and it thus prevents undue access of air. As to strength, we can say, from actual experiment, that it is increased upward of 1,000 per cent. A strip of ordinary white Swedish paper, one-fifth of an inch wide, will sustain a load of from half to three-quarters of a pound avoirdupois, according to the quality of the paper. A similar strip of the toughened paper broke, in three trials, with 5 lb. 7 oz. and 3 drms.; 5 lb. 4 oz. and 36 grains, and 5 lb. 10 oz. respectively. These are facts that deserve to be better known than they seem to be to the profession at large.—National Druggist.

To Whiten and Clean Ivory Articles.—If simply dirty, scrub with soap and tepid water, using an old tooth or nail brush for the purpose. Grease stains may be sometimes removed by applying a paste of chalk or whiting and benzol, covering the article so that the benzol may not dry too rapidly. Carbon disulphide (the purified article) may be used in place of benzol. When dry, rub off with a stiff brush. If not removed with the first application, repeat the process. Delicately carved articles that show a tendency to brittleness should be soaked for a short time in dilute phosphoric acid before any attempt to clean them is made. This renders the minuter portions almost ductile, and prevents their breaking under cleaning. The large scratched brush should be treated as follows: If the scratches are deep, the surface may be carefully rubbed down to the depth of the scratch, using the finest emery cloth, until the depth is nearly reached, then substituting crocus cloth. To restore the polish, nothing is superior to the genuine German putz pomade, following by rubbing first with chamois and finishing off with soft old silk. The more "elbow grease" put into the rubbing the easier the task, as the heat generated by friction seems to lend a sort of ductility to the surface. To remove the yellow hue due to age, proceed as follows: Make a little tripod with wire, to hold the object a few inches above a little vessel containing lime chloride moistened with hydrochloric acid; put the object on the stand, cover the whole with a bell glass, and expose to direct sunlight. When bleached, remove and wash in a solution of sodium bicarbonate, rinse in clear water and dry.

Photographical Postal Card.—The Papier Zeitung gives the following method of preparing paper for photographical purposes, which is so simple that it may be applied to postal cards. Any well "sized" paper is available for the purpose, however, and even an unsized paper may be employed, provided it be treated with a 10 per cent. solution of gelatin in water carrying 2 per cent. of arrowroot (i. e., made soluble by boiling). A 50 per cent. decoction of carragheen is also available for the purpose. This, which is really a sizing, may be applied to the surface of the paper with a broad, flat pencil.

A surface thus prepared is far better, and the pictures thereon are stronger than when an unsized paper is employed.

Having prepared your paper, go over the surface (after letting it dry thoroughly), using a similar pencil, with a solution of 10 parts iron oxalate in 100 parts of distilled water, and let dry. With a clean pencil, kept especially for the purpose, again go over the surface with a 1 per cent. solution of silver nitrate in distilled water, and let dry. Red light must be used in these two operations.

The paper is now ready for use, and under proper precautions, chief of which is the absolute exclusion of light, will keep for several days.

In printing make a strong copy, and develop in the following bath:

Distilled water	400 parts.
Potassium oxalate, neutral	80 parts.

Mix. After development, wash thoroughly and fix in the following bath:

Distilled water	100 parts.
Sodium thiosulphate	5 parts.
Gold chloride solution, 1 per cent	5 parts.

Mix. This is the bath recommended, but other baths may be used.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Cost of Running Automobiles.—The following article from The London Daily Mail gives costs of operation of automobiles, says Consul Marshal Halstead, of Birmingham:

Now that at last the automobile movement may be said to have begun in earnest in this country, some amount of interest naturally centers in the question of heavy motor vehicles.

These are undoubtedly destined to replace horse-drawn wagons in the near future, and, if they had nothing else to recommend them, motor-driven wagons, etc., would appeal to firms who at present use horses solely on account of the difference in working expenses.

Mr. E. H. Bayley, of Bayley's Wagon Building Works, gave a Daily Mail representative some interesting particulars on this point yesterday. He is entitled to speak with some amount of authority, as he was chairman of the London Road Car Company, and now, in addition to employing 1,000 or so horses in his own business, is chairman of the Daimler Motor Company, and takes a keen interest in all that tends to lessen the cost of heavy traffic.

"Of course," he said, "no matter how excellent motor-driven wheels may be, no one would look at them seriously if their use were more expensive than that of horses. That is exactly where the ultimate success of motor vehicles lies, for the tests by the Automobile Club at Richmond and, more recently, those held by the Liverpool Self-Propelled Traffic Association have shown that not only can motors do general carrying work more quickly and more efficiently than horses, but—most telling point of all—do it at less than one-seventh of the cost.

"For instance, we have a car which has been proved, under the tests already mentioned, to be capable of carrying a load of 3 tons 12 cwts. at a cost for fuel which works out a half-penny per ton-mile. The total upkeep of such a vehicle, when all expenses for working, wages, fuel, repairs, insurance, etc., are taken into consideration, comes to a sum of £407 0s. 3d. ($1,980.73), and this, with a carrying capacity for two hundred and sixty working days, gives an average cost of a fraction under 3 half-pence (3 cents) per net ton per mile.

"When that is compared with the cost of horses—my experience teaches me that it varies from 9d. to 1s. (18 cents to 24 cents) per ton per mile—it can be seen what a future such vehicles have before them. In this branch of automobiles England has the lead, and presently she will not be so far behind with light carriages, for the Daimler Company is taking up the question of building racing cars to compete with those of French manufacture.

"Already, three orders for cars costing £1,000 ($4,866.50) each have been placed, which shows that English enthusiasts are prepared to support home industries if given the opportunity."

The London Daily Mail is publishing an automobile column once a week. Mr. Alfred Harmsworth, the editor of The Daily Mail, will not object, I imagine, to my stating for publication that he is an automobile enthusiast, and believes it patriotic for a man of means to purchase the best types of automobiles, foreign or British. This he does in order to create a greater interest in them in this country, so that the British manufacturers shall not, for lack of examples or cash encouragement, be behind the American or French manufacturers in this respect.

Belgian Vehicle Regulations.—Under date of Brussels, August 28, 1899, Consul Roosevelt transmits the following:

The various accidents which have caused so much popular and press agitation have at last resulted in legislation on the subject of carriages, bicycles, and automobiles, and the following rules will be enforced by the police:

All carriages must keep to the right throughout Belgium.

All self-propelled carriages, not bearing the regulation number of the province, must carry the owner's name and address.

All automobiles and autocycles must carry, both in front and behind, a number large enough to be seen at a distance, and after sunset each number must be lighted by a lamp.

All automobiles, autocycles, and bicycles, without exception, must be provided with a brake.

Road racing is forbidden, except with the consent of the burgomasters (mayors) of the villages through which the racers pass.

The maximum speed allowed is 30 kilometers (18·64 miles) an hour in the open country, and 12 kilometers (7·46 miles) an hour in towns.

Cyclists are strictly enjoined to keep their hands on the handles and their feet on the pedals while riding.

Cyclists are allowed to choose their own alarm bell, but rubber-tired carriages must carry bells.

Emigration of Jews to Palestine.—Minister Straus writes from Constantinople, September 13, 1899, in regard to the unfortunate condition of the immigrant Jews, many of whom appear to be paupers. He incloses a letter from Consul Merrill, of Jerusalem, which reads in part:

The Turkish regulation requiring Jews arriving at Yafa to leave the country again in thirty or ninety days, if they come as visitors, has, I understand, been agreed to by our government. There is no provision, however, so far as I have been informed, as to how these people are to be made to return. As the Turks do not accept the word of the immigrants on landing, a system of money pledges has been resorted to. This may be called "fine," "tax," "deposit," "bachshish," "bail," or "pledge." It is a money guarantee that the parties will carry out the requirement of the Turkish government. Unless they pay the guarantee, the immigrants have great trouble in landing. In many cases, the consul is appealed to, and rather than see them starve or sent back to the steamer, which would probably not receive them again, he gives his word as security that they will leave the country at the expiration of the time specified. Respectable American Jews, coming here as bona fide travelers, encounter no more trouble than do Christian travelers. It is the immigrant class—Russian or Polish Jews—who are suspected by the authorities here as likely to swell the ranks of the colonists.

American Railway Machinery in India.—Consul-General Patterson writes from Calcutta, September 14, 1899:

On the 31st of August last I made a report on the railways of India,* in which I called the attention of our manufacturers of railway supplies to this market for their products. I now inclose the following clipping from The Englishman of this city of the 13th instant, as forcibly corroborating the statements made in that report:

RAILWAY MACHINERY FROM AMERICA.

The steamer "Falls of Keltie" arrived at Rangoon on the 4th instant from New York, with twenty locomotives and seventy-five railway carriages and other parts of railway machinery for the Burma railways. Mr. J. J. Ellis, of Messrs. Barber & Company, New York, has been specially sent out by this firm, which has chartered the "Falls of Keltie" and is the agent of various well-known American iron companies, to superintend the work of delivering the machinery. This is the first voyage of the "Falls of Keltie" to Rangoon. She left New York on the 24th of June and Alexandria on the 18th of July, arrived at Aden on the 3d of August, Bombay on the 13th, and Colombo on the 27th, and left again for Rangoon on the 29th. She left New York with the largest quantity of machinery that was ever put aboard one boat, viz., railway material for Alexandria, Bombay, and Rangoon, and American oil for Colombo.

Steel-Plate Roadway in Great Britain.—Consul Hopley writes from Southampton, September 18, 1899:

In the county of Down, Ireland, is a steel-plate roadway, known as the Benbrook and Newry Electric Railway. It is only 3 miles long, and has a rise of 180 feet. It has been in operation for sixteen years; it is an ordinary railway of 3-foot gage. All the trains are mixed trains (passenger and goods or freight combined). The passenger line is built of ordinary steel rails, outside of and adjoining which is a lower line of steel rails. The wagons without flanges on the wheels run on the lower outside rails; the inner rails for the cars are high enough above the outer rail to act as a guide to the wagons, keeping them on the track. On either end of the line the wagons are detached from the train and taken to their destination over the regular streets and roads by horses. There are no terminal charges, so the cost of handling is light. There is no delay or difficulty in getting the wagons on or off the ends of the line. The cost of the road, including land and all, was about £16,000 ($77,860).

Silk and Tea in China.—Consul-General Goodnow, Shanghai, on August 24, 1899, sends copy of an imperial decree ordering the local authorities to consider what should be done to improve the quality of silks and tea. The consul-general adds:

In 1897, a large proportion of Pingsuey tea could not pass United States inspection. I wrote to the local authorities in the regions producing those teas, and these authorities issued proclamations calling attention to the necessity of more careful preparation of teas. Last year, very few shipments were rejected. A little attention by the local Chinese authorities will undoubtedly result in the proper preparation of the silk and tea.

The decree reads:

THE NECESSITY OF INTRODUCING IMPROVEMENTS IN TRADE.

The board of punishments has handed to us a memorial stating that the export of silk and tea from China has not equaled of late the value of imports from foreign countries, in consequence of which the country is annually drained of large amounts for which there is no return. Of late, the manufacture both of silk and tea has deteriorated, resulting in a reduction of the export of these two commodities. It is vitally necessary that these manufactures should be improved at once, in order to increase the demand for them in foreign countries, and the memorial recommends the establishment without delay of schools and workshops to teach Chinese the science of making silk and tea and other things according to Western methods, which are far superior to the antiquated methods of China. The viceroys and governors of treaty ports and of provinces which produce silk and tea for export are hereby commanded to consider without delay what should be done in the matter and report to us.

South African Trade Notes.—Consul-General Stowe writes from Cape Town, August 25, 1899:

I am pleased to note that during the ten months ending April 30, 1899, the increased importation of boots and shoes into South Africa from the United States was £645 ($3,138.89). For the same period, the imports of all kinds of goods from the United States into Natal increased £198,520 ($966,097.58), while from Great Britain and all her dependencies the increase was only £139,522 ($678,983.81).

A box-making factory has been started on quite a large scale in Natal, four machines having been imported from England.

The Natal Gazette shows estimates for the expenditure of £218,406 ($1,162,872.80) for building new lines of railway and cars. A sum of £73,000 ($355,254.50) was named for locomotives and £3,000 ($14,599.50) for new furniture for government use. It is also in contemplation to build cold-storage plants at the principal railway depots. Demands are noted for piping for waterworks.

American Iron in Germany.—When, some time ago, American competition in iron and steel was talked of in the German press, many of the technical and trade journals made light of the news, says Vice-Consul-General Hanauer, of Frankfort. Quite different, however, is the expert opinion of the Chamber of Commerce of Bochum, which comprises leading manufacturers from this prominent iron and steel district of Germany. In its annual report for 1898 this body speaks as follows:

American competition, which in 1897 arose in the Continental markets, has made further progress during 1898. Pig iron exported to Germany has increased 16 per cent., as compared with the imports of the year previous, fine cast iron and wrought iron 28 per cent., and common ironware 75 per cent., while the import of bicycles and parts gained 106 per cent.

The value of these American articles imported into Germany in 1897 amounted to 10,100,000 marks; in 1898, to 15,800,000 marks ($2,380,000 to $3,570,000). This extraordinary increase in so short a time gives cause for very serious concern, especially when it is considered that the demand in the United States has advanced enormously, so that no large stocks were available for foreign export.

Consequently, we have to reckon with certainty that the import of American iron and steel will continue to increase; to prevent it will require strenuous exertions on the part of German works. Above all, we must have lower freight rates. Without these it will be impossible for the Rhenish Prussian iron manufacturers to compete in future with American goods, which gain great advantage from the astoundingly low rates of railroad freights.

Cranberry Cultivation in Canada.—At a large meeting of fruit growers of New Brunswick and Prince Edward Island, which recently took place in Charlottetown, at which some important questions in reference to the growing of cranberries were considered, one of the leading fruit growers gave his experience with cranberries, of which the following is a synopsis, says Gustave Beutelspacher, commercial agent at Moncton:

Some years ago, while clearing some land, I discovered a patch of cranberries. Not knowing the value of it, I prepared the land for a crop of oats. When the oats were reaped, the vines were so healthy that I concluded there was something in them, and so I fenced the patch. After a few years, a quart was picked. The year following I gathered 2 bushels, the next year 7 bushels, and the following 20 bushels. I then began exhibiting my fruit at the exhibitions, where I carried off prizes. There are several varieties, but mine is the Cherry Bell, which takes well in the English market. The land for planting cranberries should be worked up and sanded, the sand to be from 3 to 6 inches deep. The irrigation is important—in fact, is essential to cranberry growing. The land should always be kept damp. Before the frost comes, the patch should be flooded and kept so until May 1. The berries do not thrive well when exposed to the winter's frost. If a long spell of dry weather takes place in the summer, irrigation should be repeated.

I realized $300 net for what I grew on 1 acre last year. I would like to know if there is anything else one could put an acre to that would bring the same returns. Sand will correct all weeds. As to prices, I realized 10s. to 13s. ($2.43 to $3.16) for mine in the English market, while others only received 9s. to 11s. ($2.19 to $2.68). I ship in boxes. The expense amounts to about 7 cents per box. It costs 70 cents per box for freight around by Montreal, but this should be very materially reduced now, as we have direct steam communication.

I have now 15 acres under cultivation, and all my neighbors have taken up the industry, although they laughed at me when I started mine. I can recommend the cultivation of cranberries as a profitable business, from the experience I have had.

Agricultural Conditions in Ontario.—The Department has received the following from Mr. C. C. James, Deputy Minister of Agriculture of Ontario, dated Toronto, September 26, 1899:

"The attention of this department has been called to the report of Consul Seyfert, of Stratford, which appears in Advance Sheets No. 534 (September 21, 1899). This report has been copied into a number of papers, and, unless it is carefully read, the reader is apt to apply it to a larger area of the Province than the consul originally intended. The condition here referred to applies to but a very small area indeed. The consul has probably been in the very center of the district which has fared worst. The condition of affairs there referred to is not very widespread. The crops on the whole have been quite up to the average, the only exception being fall wheat, which suffered from the severity of last winter."

Fruit Trees in South Africa.—Consul-General Stowe, of Cape Town, under date of August 23, 1899, says:

While drafted American vines are appreciated and well known here, the government having offered premiums on such stock, the fruit and ornamental trees and shrubs of the United States have not been introduced. A representative of a United States nursery has been here eight weeks, and he assures me that he has sold more in that period than he could have sold in the United States in twenty-four weeks. He has only been canvassing this city and suburbs and is now compelled to leave for the United States. Fruit of nearly all varieties can be cultivated here, but growers must be educated. As there are no frosts, the insects and their larvæ are not killed as in countries where frost occurs; consequently a large number of trees die. This can be prevented if the people would use the same care and adopt the methods and appliances that have become so necessary and so efficient in the United States.

This brings me to the suggestion that the chemical preparations and spraying pumps used in the United States could be introduced into this country with profit. No agent must come here expecting to stay only a few weeks; he must come to instruct and to prove the advantages of his goods. American fruit and ornamental trees, shrubs, etc., will find a market when properly introduced.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

*See Advance Sheets No. 549 (October 10, 1899).

SOME PHYSIOLOGICAL EFFECTS OF HYDROCYANIC ACID GAS UPON PLANTS.*

IT is a well known fact that the discovery of hydrocyanic acid gas as an insecticide belongs to Mr. D. W. Coquillett, of the United States Department of Agriculture. He discovered this, experimenting in California in 1886, with a view of finding a remedy for the destruction of the cottony cushion scale, Icerya purchasi, infesting the orange orchards. He found that hydrocyanic acid gas applied within inclosure (tents) was a deadly gas to the animal or insect life upon the trees. He completed his work in 1889; and from that date up to the present time, hydrocyanic acid gas has been used extensively in seven counties in southern California in the Citrus orchards for the destruction of the black scale and the red scale which militates so much against the successful growing of oranges. In fact, they found that they could not spray against these scales because it was necessary to use the spray when the fruit was on, which ruined it for commercial purposes. Thus it was necessary to have some element that could be used when the tree was in full foliage and full fruit; and this gas thus came into common use.

GENERAL VIEW OF EXPERIMENTAL OUTFIT AT WORK WITH TENTS, 1897.

Before 1895 the gas had not been used in greenhouses with any very great degree of success. In that year Dr. A. F. Woods, of the United States Department of Agriculture, undertook a series of experiments, assisted by Mr. P. H. Dorset, and proved conclusively that the gas could be used in greenhouses under glass to great advantage for the destruction of those insects infesting the various greenhouse plants, such as coleus, violets and various other plants, that are difficult to spray for the destruction of insects. In this series of experiments Woods and Dorset have proved conclusively that plants are less injured by a short exposure to a relatively large amount of gas than by a long exposure to a relatively small amount; and also that a stronger dose a short time was more destructive to the insects affecting the plant. They further demonstrated the physiological effect of the gas upon the plants by subsequent experiments. They summed up the resisting power of the plant as dependent largely upon the open and closed conditions of the breathing pores of the leaf, the peculiarities of the cell contents and the temperature of the inclosure.

I found the same variations in the field, where we used the gas largely in the control of San Jose scale and other insects. The first problem I had to take up in this connection was the physiological effect of the gas upon the deciduoas trees in the East. While it had been used successfully in California, we must bear in mind that while the orange trees were in full foliage they could not use the gas in the daytime, as it injured the leaves; and all their experiments were, therefore, conducted at night. It was not an uncommon thing to see the men with their implements going into the orchards at sundown, working until sunrise. We did not find the same conditions existing here in the East. With our experiments we did not begin with the deciduous trees until the function of the foliage had been performed; namely, late in the fall, just previous to the heavy frosts. These experiments were conducted in later September and early October. It made no difference to us whether we scorched or burnt the leaves; our main point was to determine what physiological effect the treatment was going to have upon the fruit or leaf development for the following season.

The next practical application of the gas outside of that of Woods and Dorset was its use in the East for the fumigation of nursery stock and our deciduous trees in orchards. As no precise experiments have been conducted in large bearing orchards in the East, the writer began a series in March, 1897, upon young apple, peach, nectarine, plum and pear.

The trees varied in height from four to six feet, were thoroughly dormant, and badly infested with the San Jose scale. They were placed in a room 4 × 7 × 7½ feet prepared for that purpose. A general, miscellaneous lot were exposed thirty minutes in gas generated from 0·20 gramme of cyanide of potassium per cubic foot of air space inclosed. Another lot was exposed to gas from 0·20 gramme up through the series formed by adding 0·05 gramme each time until 0·50 was reached. All the trees of these lots have been observed very closely. No injury was noticed, and not a living scale has been detected upon it. The cyanide used in these experiments was the 98-99 per cent. pure, while the cyanide used in the California orchards was the old 58 per cent.; so we must take that into consideration when considering the effects and amounts used.

In the fall of 1897 I began perhaps the largest series of experiments ever undertaken in the East for the destruction of San Jose scale. The orchard chosen was a nine year old Bartlett dwarf pear, and the trees were in full foliage. Canvas tents were used for this purpose. The trees were fumigated at all hours of the day, and under varying conditions of weather. We had sunshine, cloudy and foggy days, rain, sleet and snow, windy and calm weather. In one series of experiments, September 29 (70° F.), we used 0·40 gramme potassium cyanide per cubic foot, instead of 0·20, as in most of our experiments. The leaves on all the trees were very brown, in fact almost black. Within five minutes after the tents were removed the petioles were black almost to the base; the leaves fell a few days later. The following spring the leaves came out as normally as on any other trees in the orchard where no fumigation occurred. There was about one-quarter as much fruit on these trees as upon those that had been fumigated with the normal strength; that is, 0·20 gramme. Other trees were treated at night with the same double dose, at 58° F. The foliage the first week showed no effect whatever and remained just as green as the trees not fumigated. The eighth day, however, the leaves began dropping and in a few days later were all off. The leaf buds came out in the following spring; but the fruit was only about half as abundant. The double dose, it would therefore seem, is injurious at least to the fruit buds.

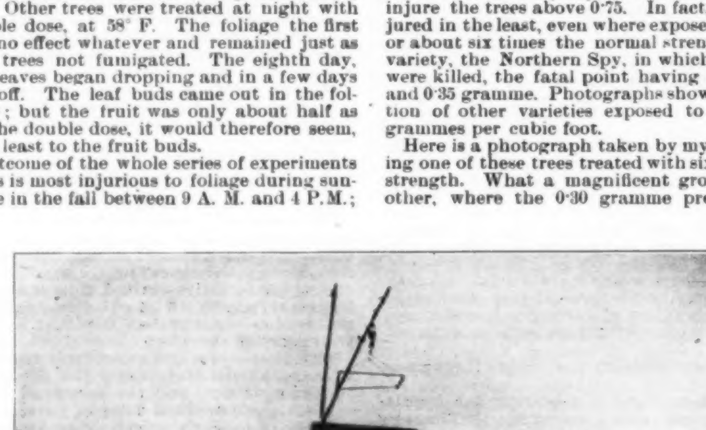
The final outcome of the whole series of experiments shows that gas is most injurious to foliage during sunshiny days late in the fall between 9 A. M. and 4 P.M.; that the dormant leaf and fruit trees treated with 0·20 gramme per cubic foot were not injured; third, that burned leaves fall readily: that trees treated in the morning before 9 o'clock and in the afternoon after 4 o'clock, even in sunshine, have the leaves very little affected; that trees treated at night with normal doses do not have the foliage hurt at all.

On March 18, 1898, I began experiments upon plum trees, using the same standard dose, just as the buds were unfolding, and observed no injurious effects whatever. June 3, 1898, eight young plum trees, in height from 8 to 10 feet, were fumigated with 0·16 gramme. The exposure varied from 5 to 12½ minutes in a sun at 80° F.; in every instance all the lice were killed and the foliage not injured. July 8, 1898, three cherry trees were fumigated with 0·16 gramme from 5 to 10 minutes. The trees were infested with the cherry slug. A five minute exposure did not injure the foliage at all, but did not destroy over 60 per cent. of the slugs; on the other hand, 7½ to 10 minutes destroyed all the slugs, but severely hurt the leaves. June 13, 1898, two pear trees, badly blighted, were fumigated with 0·20 gramme per cubic foot, for 6 and 10 minutes respectively. We could see no bad effect on the leaves and no decrease in the blight. In April, 1899, after the buds had begun to open, I completed some experiments, using 0·20 gramme, upon pear trees. These other tests had been made during the fall, midwinter, early spring, and now we took up the late spring, as the buds began to open.

We wish to show you here the equipment which we have now perfected and are using for this purpose. This is a decided improvement over the old tent, perfect in its operation, and one which is destined to come into common use where it is necessary to use hydrocyanic acid gas. The new apparatus consists of a canvas box with extension hood as shown in the illustration. It is put over a tree and removed by means of a mast and gaff, rigged as shown in the photograph. It is easily handled, and has many advantages over the old tent. It has a constant capacity, so that the amount of chemicals does not vary.

Experiments were also performed this spring upon nursery stock for the purpose of determining the precise effect of the gas upon young trees used at a strength greater than 0·25 gramme per cubic foot. Owing to the fact that in some States they are stipulating by law now that trees must be fumigated, it became absolutely necessary that we know definitely the effects of this gas upon growing plants, especially the dormant trees. No recent experiments have been recorded along this line, as far as I know; and it became very important that we should know the physiological effect of the gas upon various varieties of nursery trees, inasmuch as some States stipulate by law that all trees before leaving the nursery shall be fumigated. Such a system is in operation in Maryland; and 36 fumigation houses are in action. Canada has also adopted our method and now has 75 houses in operation in the Province of Ontario. We have been using 0·25 gramme in our general work and recommend that strength for Canadian stock above 3 feet in height. We began our experiments with the stronger doses, March 29, 1899; the apple trees were divided into twenty different lots (five trees each), leaving five for a check. They were 4 to 5 feet in height, and of the following varieties: Ben Davis, Northern Spy, Timbertwig, Wealthy, Fall Pippin, Oldenburg, Stark, Rome Beauty, Schoekly and York Imperial. They were exposed in gas one hour and each lot was fumigated with 0·25, 0 30, 0·35, 0·40, 0·45 and so on, adding 0·05 to each one until we reached 1·00, then skipping from 1·00 to 1·25, to 1·35 and 1·45 grammes, thus completing the series. The trees were labeled and planted and have been under observation the entire season. The outcome of these experiments is as follows: I had fully expected that the gas would badly injure the trees above 0·75. In fact, no trees were injured in the least, even where exposed to 1·45 grammes, or about six times the normal strength, excepting one variety, the Northern Spy, in which eight out of ten were killed, the fatal point having been between 0·25 and 0·35 gramme. Photographs show the perfect condition of other varieties exposed to the 1·35 and 1·45 grammes per cubic foot.

Here is a photograph taken by myself July 31, showing one of these trees treated with six times the normal strength. What a magnificent growth! Here is the other, where the 0·30 gramme proved fatal to the Northern Spy. That is brought in comparison with the Ben Davis. I cannot explain why Northern Spy was more susceptible to the gas than the others, as it is naturally a hardy tree, and I would have expected its resisting properties to be as great as Ben Davis or any of the others with which it was treated. The condition of the Spy was about the same, and the buds had just begun to swell. I am of opinion that the death of Northern Spy was not due to the gas only.



GENERAL VIEW OF NEW BOX SYSTEM AT WORK, APRIL, 1899.

April 17 and 18, twenty plum trees, 2 to 4 feet high (Abundance, General Hand, Genii, Lombard, Ogon, Shipper's Pride, and Spalding), were fumigated, each one hour exposure, with 0·35, 0·45, 0·55, 0·65, 0·75, 1·25, 1·35 and 1·45 grammes. The results obtained are very striking; for instance, there was no damage whatever to any varieties until 0·65 gramme was reached, when

* A paper by State Entomologist W. G. Johnson, of the Maryland Agricultural College, read August 24, 1899, at the Ohio State University, Columbus, O., before the Botanical Section of the American Association for the Advancement of Science. Revised by the author especially for the SCIENTIFIC AMERICAN SUPPLEMENT.

the Spalding had terminals slightly injured, while General Hand was not hurt; at 0·75 gramme, Ogon had terminals slightly injured, while Spalding was killed to the ground, but later sent out shoots. In the 1·00 gramme, Ogon was again only slightly hurt, while Abundance was dead to the surface of the ground. From 1·00 to 1·35 Ogon was slightly injured on the terminals. At 1·45 grammes Abundance was killed, as in the preceding experiments.

The peach experiments were commenced April 26, 1899, after the buds were beginning to unfold. We

APPLE FUMIGATED ONE HOUR WITH 0·30 GRAMME CYANIDE.

used 250 trees, one-half of which were first grade (Peninsula Yellow), 4 to 5 feet, while the others were very small, varying from 1½ to 2 feet high. The trees were divided into lots of 5 each, and both grades treated from 0·25 to 1·45 grammes per cubic foot, 0·05 gramme being added each time. In every instance the short grade trees were killed outright, or the tops were killed, a few feeble shoots coming out from near the ground, later. This corresponds to results a year ago, that June-budded peach and small whip-like trees from 1½ to 2½ feet cannot withstand more than 0·18 gramme for half an hour. On the other hand, with large trees there was no perceptible injury from 0·25 gramme up to 0·50 gramme, at which strength the terminals were injured slightly. In 0·75 gramme the top was killed about one-third the way down.

The engravings are self-explanatory, and prove the deadening effect with the varying degrees of gas from the top downward. From 0·75 gramme to 1·00 gramme was variable. In some instances the whole top was killed. From this point (1·00 gramme) on, up to the highest amount used (1·45 grammes) a curious fact was noticed. In almost every case the injury was not as great above 1·00 gramme as below 0·75 gramme. In 1·35 and even 1·45 the trees were only slightly injured at the top, resembling the effects produced at 0·50 gramme.

In general, we can say that the danger point, where well matured nursery stock is injured by hydrocyanic acid gas, is so far above the standard used that practically no damage can result from an overdose. With apple and pear there is practically no injury even in the strongest applications. Plum is slightly more susceptible, being injured at 0·65; in peach the injury began at 0·50, in well matured trees; but it is fatal in low-grade trees at above 0·18 gramme.

ANTHROPOLOGY.

OPENING ADDRESS BY C. H. READ, PRESIDENT OF SECTION H, BRITISH ASSOCIATION.

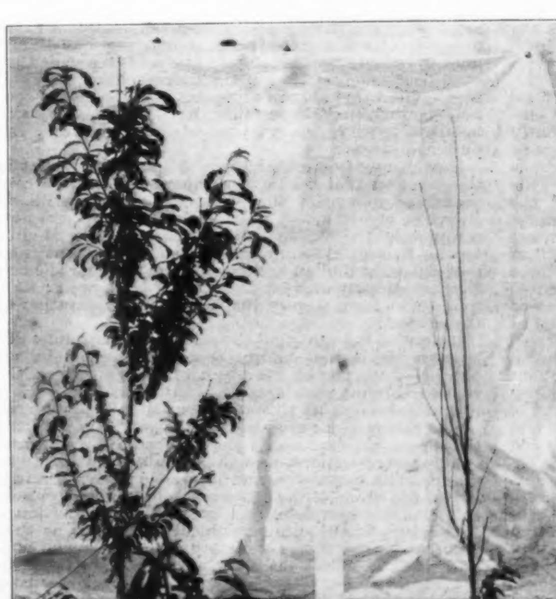
THE difficulties that beset the President of this section in preparing an address are chiefly such as arise from the great breadth of our subject. It is thought by some, on the one hand, to comprehend every phase of human activity, so that if a communication does not fall within the scope of any other of the sections into which the British Association is divided, it must of necessity belong to that of anthropology. On the other hand, there are many men, wanting neither in intelligence nor education, who seem incapable of grasping its general extent, but, mistaking a part for the whole, are fully content with the conclusions that naturally result from such a parochial method of reasoning. The Oxford don who stated a year or two ago his belief that anthropology rested on a foundation of romance can only have arrived at this opinion by some such inadequate process, and the conclusion necessarily fails to carry conviction. The statement was, however, singularly ill advised, for anthropology gives way to no other branch of science in its reliance upon facts for its existence and its conclusions. Had the reproach been that the facts were often of a dry and repellent character, we might have pleaded extenuating circumstances, but I fear it must have been admitted that there was some justice in the complaint, though we could fairly point to instances where master minds have made even the dry bones of anthropology live, and that without trenching upon the domain of romance.

It is not, however, my purpose to-day to enter upon a general defense of anthropology as a branch of science. It has taken far too firm a hold upon the popular mind to need any such help. I intend rather to treat of one or two special subjects with which I am in daily relation, in order to see whether some practical means cannot be found to bring about a state of things more satisfactory than that at present existing.

The first of these branches is that of the prehistoric antiquities of our own country. It will not be denied that there can be no more legitimate subject of study than the remains of the inhabitants of our islands from the earliest appearance of man up to the time when written history comes to the aid of the archæologist. There is no civilized nation which has not devoted some part of its energies to such studies, and many of them under far less favorable circumstances than ours. The chiefest of our advantages is to be found in the small extent of the area to be explored—

PEACH FUMIGATED ONE HOUR WITH NORMAL DOSE.

an area ridiculously small when compared with that of most of the Continental nations, or with the resources at our command for its exploration. The natural attractions of our islands, moreover, have also had a great influence on our Continental neighbors, so that their incursions have not been few, and no small number of them decided to remain in a country where the necessaries of life were obtainable under such agreeable conditions. The effect of these incursions, so far as our present subject is concerned, is that there is to be found in the British Islands a greater variety of prehistoric and later remains than is seen in most European countries, a fact which should add considerably to the interest of their exploration. At the same time, also, it must be borne in mind that it is by such researches alone that we can arrive at any true



PLUM FUMIGATED ONE HOUR WITH FOUR TIMES NORMAL DOSE.

PEACH FUMIGATED ONE HOUR WITH FOUR TIMES NORMAL DOSE

understanding of the conditions of life, the habits and religious beliefs, or the physical characters of the varied races who inhabited Britain in early times.

It may seem unnecessary to urge, in face of these facts, that all such memorials of the past should be, in the first place, preserved; and, in the second, that any examination of them should be undertaken only by properly qualified persons. Unfortunately, however, it has never been more necessary than it is at the present time to insist upon both points, and the fact that these prehistoric remains are scattered impartially over the whole country, with the exception, perhaps, of the sites of ancient forests, makes it almost impossible to devise any special measures for their preservation. An additional difficulty is to be found in the fact that many ancient remains, such as the barrows of the early Bronze Age, are altogether unrecognized as such, and in the process of cultivation have been plowed down almost to the level of the surrounding surface, until at last the plow scatters the bones and other relics unnoticed over the field, and one more document is gone that might have served in the task of reconstructing the history of early man in Britain.

Such accidental and casual destruction is, however, probably unavoidable, and, being so, it is scarcely profitable to dwell upon it. We can, perhaps, with more advantage protest against willful destruction, whether it be wanton mischief or misplaced archæological zeal. An enlightened public opinion is our only protection against the first of these, and will avail against the second also, but we are surely entitled to look for more active measures in preventing the destruction of archæological monuments in the name of archæology itself. It is a far more common occurrence than is generally realized for a tumulus to be opened by persons totally unqualified for the task either by experience or reading. An account may then be printed in the local journal or newspaper. When such accounts do appear, it is often painfully obvious that an accidental and later burial has been mistaken for the principal interment, while the latter has been altogether overlooked, and no useful record has been kept of the relative positions of the various objects found. The loss that science has suffered by this indiscriminate and ill-judged exploration is difficult to estimate, for it should be borne in mind that an ancient burial once explored is destroyed for future searchers—no second examination can produce results of any value, though individual objects overlooked by chance may repay the energy of the later comers. So much varied knowledge is, in fact, required for the proper elucidation of the ordinary contents of a British barrow that it is almost impossible for any single person to perform the task unaided. A wide experience in physical anthropology must be combined with an acquaintance fully as wide with the ordinary conditions of such interments and the nature, material, and relative positions of the accompanying relics, all of which must be brought to bear, with discriminating judgment, on the facts laid bare by the digger's spade. Added to this, the greatest precaution is needed that nothing of value be overlooked. In some soils, such as a stiff clay, it is almost impossible to guard against such a casualty, especially when the barrow is of large size and vast masses of earth have to be moved. The amount of profitable care that may be bestowed on scientific work of this character can nowhere be better seen, I am glad to say, than in our own country, in the handsome volumes produced by General Pitt-Rivers as a record of his investigations in the history of the early inhabitants of Dorsetshire. The memoirs contained in them are unsurpassed for scientific thoroughness, and they will probably long stand as the model of what archæological investigation should be. It is very seldom, however, that circumstances conspire so favorably toward a desired end as in the case of General Pitt-Rivers, where a scientific training is joined to the love of research, and finally ample means give full scope for its practice under entirely favorable conditions. While it is, perhaps, too much to expect that all explorations of this character should be carried through with the same minute attention to detail that characterizes General Pitt-Rivers' diggings, yet his memoirs should be thoroughly studied before any work of the same kind is entered upon, and should be kept before the mind as the ideal to be attained. It is not too much to say that a diligent study of the works of the two foremost explorers of prehistoric remains in this country—Canon Greenwell and General Pitt-Rivers—will of itself suffice to qualify any intelligent antiquary to conduct the exploration of any like remains. At the same time, it must not be forgotten that exploration is one thing and a useful record of it is another, and here the explorer would do well to invite the co-operation of specialists if he would get the full value out of his work, and there is generally little difficulty in getting such help.

I have ventured to point out, in moderate terms, the dangers to which a large number of our prehistoric

sites are liable, and to state under what conditions they should be investigated. It is not unreasonable to expect, if the danger is so obvious, that a remedy should be forthcoming to meet it. In most of the Continental States it would be easy to institute a scheme of State control by which such sites would vest in the government to just such an extent as would be necessary to prevent their being destroyed, and such a scheme might be cheerfully accepted and applied with success in any country but our own. Here, however, we are so accustomed to rely upon individual influence and exertion in matters of this kind, that an appeal to the government is scarcely thought of; while, on the other hand, the rights of property are fortunately so safeguarded by our tradition and law that nothing but a futile act of Parliament would have the least chance of passing. Moreover, experience teaches us that it is not to State control that we must look. The ancient monuments bill, which was intended to protect a special class of monuments, and was framed with a full regard to the rights of owners, still stands in the statute book, but for years past it has had no effective value whatever. That being so, we must look to private organizations, and preferably to those already in existence, for some effectual moral influence and control, and, in my judgment, the appeal could best be made to the local scientific societies. Many of these are very active in their operations, and could well bear an addition to their labors; others, less active, might become more energetic if they had a definite programme.

The plan I would propose is this: Each society should record on the large scale ordnance map every tumulus or earthwork within the county, and at the same time keep a register of the sites with numbers referring to the map, and in this register should be noted the names of the owner and tenant of the property, as well as any details which would be of use in exploring the tumuli. I am well aware that a survey of this kind has been begun by the Society of Antiquaries of London, and is still in progress; but this is of a far more comprehensive character, and is, moreover, primarily intended for publication. The more limited survey I now advocate would in no way interfere with it, but, on the contrary, would provide material for the other larger scheme. Once the local society is in possession of the necessary information just referred to, it would be the duty of its executive to exercise a beneficent control over any operations affecting the tumuli, and it may safely be said that such control could in no way be brought to bear so easily and effectively as through a local society.

Some of the arguments in favor of some such protection for our unconsidered ancient monuments have been already briefly stated, and, in conclusion, I would only urge this in their favor, that while the more beautiful monuments of later and historic times are but little likely to want defenders, the less attractive early remains are apt to disappear, not so much from want of appreciation as from want of knowledge, and I would repeat that it is from them alone that we can reconstitute the life story of those who lived in what we may, with truth, call our dark ages.

I will now ask you to turn your attention to another matter in which it seems to me that this country has opportunities of an unusually favorable kind. I refer to the collection of anthropological material from races which still remain in a fairly primitive state. It is somewhat trite to allude to the extent of our empire and the vast number of races either subject to our rule or who look to us for guidance and protection. The number may be variously computed according to the bias, philological or physical, of the observer, but it will not be contested that our opportunities are without precedent in history, nor that they greatly exceed those of any existing nation. That being so, it may not be useless to see how far these opportunities are utilized.

While it will not be denied that the Indian government and the governments of some of our colonies have done excellent work in the direction of anthropological research and publication, and that exhaustive reports from our colonial officials are frequently received and afterward entombed in parliamentary papers, yet it is equally clear that work of this kind is not a part of our administrative system, but rather the protest of the intelligent official mind against the monotony of routine. The material, the opportunity, as well as the intelligence and will to use both, are already in existence, and all that is now wanted is that the last should be encouraged, and the work be done on a systematic plan, and, as far as may be, focused on some center where it may be available for present and future use. It was for this end that I ventured to bring before the British Association at the Liverpool meeting a scheme for the establishment of a central bureau of ethnology for Greater Britain. Frequent appeals had been made to me by officials of all kinds in distant parts of the empire to tell them what kind of research work they could most usefully undertake, and it seemed a pity not to reduce so much energy and goodwill into a system. Hence the Bureau of Ethnology. The council of the association, on the recommendation of the committee, invited the trustees of the British Museum to undertake the working of the bureau; this they have accepted, with the result that if the Treasury will grant the small yearly outlay, it will be under my own supervision. If I had foreseen this ending, I might have hesitated before starting a hare the chasing of which will be no sinecure.

It was considered necessary, before attempting to begin the work of the bureau by communicating with commissioners and other officials in the various colonies and protectorates, to lay the matter before Lord Salisbury and to invite his approval of the scheme. The whole correspondence will appear in the report of the present meeting, but I may be pardoned for quoting one paragraph of the circular letter from the Foreign Office to the several African protectorates. It is as follows: "Lord Salisbury is of opinion that Her Majesty's officers should be encouraged to furnish any information desired by the bureau, so far as their duties will allow of their doing so, and I am to request you to inform the officers under your administration accordingly." When it is remembered that this is strictly official phraseology, its tenor may be considered entirely satisfactory, and there can be little doubt that other departments of the government will recognize the utility of the bureau in the same liberal spirit. Thus we shall have within a short time an organization which will systematically gather the records of the many races which are either disappearing before the advancing white man, or, what is equally fatal from the anthropological point of view, are rapidly adopting the white man's habits and forgetting their own.

The Bureau of Ethnology, however, will only perform a part of the task that has to be done. While there is no doubt of the value of knowledge as to the religious beliefs and customs of existing savages, it is surely of equal importance that anthropological and ethnological collections should be gathered together with the same energy. The spear of the savage is, in fact, far more likely to be replaced by the rifle than is his religion to give way to ours. Thus the spear will disappear long before the religion is forgotten. It may be said that we have collections of this kind in plenty, and it is true that in the British Museum, at Oxford, Cambridge, Liverpool, and Salisbury, there are indeed excellent collections of ethnology, while at the College of Surgeons and the Natural History Museum there are illustrations of physical anthropology in great quantity. Whatever might be the result if all these were brought together, there can be no question that no one of them meets the requirements of the time. Here also there is a want of a system that shall at once be worthy of our empire and so devised as to serve the ends of the student. Where, if not in England, should be found the completest collection of all the races of the empire? It must be admitted, however, not only that we have no national collection of the kind, but that other nations are ahead of us in this matter.

This could be readily understood if their sources of supply were at all comparable to ours. But this is, of course, very far from being the case. The sources are ours in great part, and if we stand inactive it is not unlikely that some will be exhausted when we do come to draw upon them. It is, perhaps, better to give here a case in point rather than to rely on general statements. In the summer of last year I arranged, with the approval of the trustees, that Mr. Dalton, one of the officers of my department, should make a tour of inspection of the ethnographical museums of Germany, with a definite object in view, but at the same time that he should make a general survey of their system and resources as compared with our own. The report which he drew up on his return was printed and has recently been communicated to the newspapers; it is therefore not necessary to allude to it now, except to quote one instance confirming my statement that it is to a great extent from our colonies that material is being drawn. Mr. Dalton says: "On a moderate estimate the Berlin collections are six or seven times as extensive as ours. To mention a single point, the British province of Assam is represented in Berlin by a whole room and in London by a single case." But even this, forcible though it is, does not adequately represent the vast difference between the material at the disposal of the two countries, for it is the habit of the collectors for the German museums to procure duplicates or triplicates of every object for the purposes of exchange or study. It is thus not unlikely that the whole room referred to represents only a part of the Berlin collection from the British province of Assam.

In making these observations, I should be sorry if it were thought that I wish to advocate a dog-in-the-manger policy, or that I consider it either desirable or politic to place any restriction upon scientific work in our colonial possessions, even if such restrictions were possible. I would prefer to look at the matter from an entirely different point of view. If the German people, who are admittedly practical and business-like, think it worth while, with their limited colonies, to spend so much time and money on the establishment of a royal museum of ethnography, how much more is it our duty to establish and maintain one, and on a scale that shall bear some relation to the magnitude of our empire. The value of such museums is by no means confined to the scientific inquirer, but they may equally be made to serve the purpose of the trader and the public at large.

How can we best obtain such a museum? That is the question that we have to answer. It is scarcely profitable to expect that the government will be stirred to emulation by the description of the size and resources of the Museum für Völkerkunde in Berlin. In the British Museum there is at the present time only the most limited accommodation even for the collections already housed there, and I am well aware that these form a very inadequate representation of the subject.

It may be thought that the solution of this difficulty is easy. It is well known that the government has purchased the rest of the block of land on which the British Museum stands, and it may seem that such a liberal extension as this will form should be enough for, at any rate, a generation or two, and that a little additional building would meet immediate wants, and enable the collections, now so painfully crowded, to be set out in an instructive and interesting way. I admit that if the whole of the contemplated buildings were at this moment complete, and at least double as much space given to the ethnographical collections as they occupy at present, the difficulty would be much simplified. The collections could, at any rate, be then displayed far more worthily and usefully. Even this, however, would hardly meet the case, even if there were a certainty of the buildings being immediately begun. Such works as these, however, can only be executed in sections during the course of each financial year. Thus, even if a Chancellor of the Exchequer could be found to fall in entirely with the views of the trustees, it would still be an appreciable number of years before the completion of the entire range of galleries that is contemplated. For this reason alone I do not look forward to obtaining the space that is even now urgently wanted for some time. Meanwhile the natural and legitimate increase of the collections at the rate of about 1 to 2 per cent. per annum still goes on, and the orginal difficulty of want of room would still face us, though in a lesser degree. This estimate of the rate of increase may seem a high one; but it should not be forgotten that the science is new, and that it is only within the last few years that such collections have been made on scientific lines, instead of being governed only by the attractive character or rarity of the object. The gaps that exist in such a series as that of the British Museum, made in great part on the old lines, are relatively more numerous than would be the case in museums more recently founded. Another reason, equally cogent, for allowing far more room than is required for the mere exhibition of the objects is that, in my judgment, ethnographical collections, to be of real value, need elucidation by means of models, maps, and explanatory descriptions, to a far greater extent than do works of art, which to the trained eye speak eloquently for themselves. Such helps to understanding necessitate a considerable amount of space, though the outlay is fully justified by their obvious utility, and in any general scheme of rearrangement of the national collection they should be considered an essential feature.

There is yet another factor to be considered. It has been the fashion in this country to consider remains illustrating the physical characters of man to belong to natural history, while the productions of primitive and uncultured races generally find a place on the antiquarian side. Thus the skull of a Maori will be found at the natural history branch of the British Museum, while all the productions of the Maori are three miles distant in Bloomsbury. Such an arrangement can perhaps be defended on logical grounds, but its practical working leaves much to desire, and the arguments for a fusion of the two are undoubtedly strong. For instance, the student of one branch would be unlikely to study it alone without acquiring a knowledge of the other, while the explorers to whom we look for collections usually give their attention to both classes of anthropological material. Here again in such a case there would be a call for still more space at Bloomsbury.

If I may be permitted to add one more to the requirements of what should be an attainable ideal, I should like to say that courses of lectures on anthropology delivered in the same building that contains the collections would form a fitting crown to such a scheme for a really imperial museum of anthropology as I have endeavored to sketch. There is but one chair of anthropology in this country, and admirably as that is filled by Prof. Tylor, he would himself be the first to admit that there is ample room and ample material to justify the creation of a second professorship.

It will be admitted that if my premisses are well founded, the conclusion must necessarily be that we cannot look to the British Museum to furnish us eventually with the needful area and other resources for the installation of a worthy museum of anthropology. The difficulties are far too great for the trustees to overcome, unless by the aid of such an exhibition of popular enthusiasm as I fear our branch of science cannot at present command. Failing the British Museum, which may be called the natural home of such a collection, we must look elsewhere for the necessary conditions, and I think they are to be found, although it is possible that, however favorable these conditions may seem from our point of view, difficulties may already exist or arise later.

It is not the first time that a scheme has been thought out for the establishment of a museum or kindred institution which should represent our colonies and India. In the year 1877 the Royal Colonial Institute made a vigorous effort in this direction, and, in combination with the various chambers of commerce throughout the country, advocated the building of an "Imperial Museum for the Colonies and India" on the Thames Embankment, with the then existing India Museum as a nucleus. The arguments then brought forward were in the main commercial, but they are, if anything, more forcible now than they were twenty years ago. The competition with foreign countries has become keener on the one hand, while the bonds between the colonies and the parent country are notoriously closer and more firm than at any previous time. No moment could thus be more opportune than the present for the foundation of a really Imperial Institution to represent our vast Colonial Empire.

The last sentence has, perhaps, given an indication of my solution of the question. The Imperial Institute at South Kensington has now been in existence for some time, and has passed through various phases. But its most enthusiastic supporters will scarcely claim for it entire success in its mission. Whatever may be the underlying causes, it must be admitted that such popular support as it possesses is scarcely founded on the performance of its functions as an Imperial Institute. It would seem, therefore, that something more is wanted—a more definite raison d'être—than it has at present, and this I think it will find in being converted into such a museum of anthropology as I have indicated, but, of course, as a government institution. I am by no means an advocate of the creation of new institutions, if the old ones can adequately do their work, nor do I think that anything but ill would result from a general partition of the contents of the British Museum. The separation of the natural history from the other collections was painful, though inevitable, and no such severe operation can be performed without loss in some direction. But the removal of the ethnographical and anthropological collections from the British Museum to the galleries of the Imperial Institute would possess so many manifest advantages that the disadvantages need scarcely be considered. The government has already taken over a portion of the building for the benefit of the University of London. The remaining portion would provide ample accommodation for the anthropological museum, as well as for the commercial side, that might properly and usefully be continued; its proximity to the natural history branch of the British Museum would render control by the trustees easy; the Indian collections, which form so important a feature in the scheme of 1877, are at this moment under the same roof; and finally the University of London has but to found a chair of anthropology, and the whole of the necessary conditions of success are fulfilled.

I have but little doubt that, wherever it might be placed, the creation of a distinct department of anthropology would of itself tend to the enrichment of the collections. It must be remembered that it is only since 1883, when the Christy collection was removed to the British Museum, that the ethnographical collections there can claim any kind of completeness. Until then one small room contained the few important objects of this kind that had survived from the voyages of Cook, Wallis and the other early voyagers. The

public did not expect to find ethnography in the British Museum, and it is, in fact, only within the last few years that it has been generally realized that a gallery of ethnography exists there. If it were placed in such a building as the Imperial Institute, it would still remain part of the British Museum, and be under the guardianship of its trustees; but it would obviously command more attention and support from the public than can be expected while it remains an integral part of a large institution which has as many aims as it has departments.

I began this address by stating that it would have a practical application. I trust that to others it may seem that what I have ventured to suggest is not only possible of achievement, but would also be beneficial to the branch of science that we represent. I should like to add that, as far as possible, I have tried to state the case as it would appear to one who regarded the situation from an entirely independent standpoint, and wishing only to discover the most practical solution of what must be admitted to be a difficult question. My allegiance to the British Museum, however, may well have tinged my views, unnoticed by myself. There are many other subjects that might well have formed the subject of an address at the present time. On such occasions as these, however, it is, I think, advisable to select a subject with especial reference to the needs of the time, and I know of nothing that is at the present moment more urgent in this particular direction, and in my judgment it will tend greatly toward the true advancement of science, the object we all have at heart.

GEOGRAPHY.

OPENING ADDRESS BY SIR JOHN MURRAY, K.C.B., F.R.S., LL.D., PRESIDENT OF THE SECTION.

IN his opening address to the members of the British Association at the Ipswich meeting, the president cast a retrospective glance at the progress that had taken place in the several branches of scientific inquiry from the time of the formation of the Association in 1831 down to 1895, the year in which were published the last two of the fifty volumes of Reports containing the scientific results of the voyage of H.M.S. "Challenger." In that very able and detailed review there is no reference whatever to the work of the numerous expeditions which had been fitted out by this and other countries for the exploration of the depths of the sea, nor is there any mention of the great advance in our knowledge of the ocean during the period of sixty-five years then under consideration. This omission may be accounted for by the fact that, at the time of the formation of the British Association, knowledge concerning the ocean was, literally speaking, superficial. The study of marine phenomena has hitherto been almost entirely limited to the surface and shallow waters of the ocean, to the survey of coasts and of oceanic routes directly useful for commercial purposes. Down to that time there had been no systematic attempts to ascertain the physical and biological conditions of those regions of the earth's surface covered by the deeper waters of the ocean; indeed, most of the apparatus necessary for such investigations had not yet been invented.

The difficulties connected with the exploration of the greater depths of the sea arise principally from the fact that, in the majority of cases, the observations are necessarily indirect. At the surface of the ocean direct observation is possible, but our knowledge of the conditions prevailing in deep water, and of all that is there taking place, is almost wholly dependent on the correct working of instruments, the action of which at the critical moment is hidden from sight.

It was the desire to establish telegraphic communication between Europe and America that gave the first direct impulse to the scientific exploration of the great ocean basins, and at the present day the survey of new cable routes still yields each year a large amount of accurate knowledge regarding the floor of the ocean. Immediately before the "Challenger" expedition there was a marked improvement in all the apparatus used in marine investigations, and thus during the "Challenger" expedition the great ocean basins were for the first time systematically and successfully explored. This expedition, which lasted for nearly four years, was successful beyond the expectations of its promoters, and opened out a new era in the study of oceanography. A great many sciences were enriched by a grand accumulation of new facts. Large collections were sent and brought home, and were subsequently described by specialists belonging to almost every civilized nation. Since the "Challenger" expedition there has been almost a revolution in the methods employed in deep sea observations. The most profound abysses of the ocean are now being everywhere examined by sailors and scientific men with increasing precision, rapidity and success.

The recognition of oceanography as a distinct branch of science may be said to date from the commencement of the "Challenger" investigations. The fuller knowledge we now possess about all oceanic phenomena has had a great modifying influence on many general conceptions as to the nature and extent of those changes which the crust of the earth is now undergoing and has undergone in past geological times. Our knowledge of the ocean is still very incomplete. So much has, however, already been acquired that the historian will in all probability point to the oceanographical discoveries during the past forty years as the most important addition to the natural knowledge of our planet since the great geographical voyages associated with the names of Columbus, Da Gama, and Magellan, at the end of the fifteenth and the beginning of the sixteenth centuries.

It is not my intention on this occasion to attempt anything like a general review of the present state of oceanographic science. But, as nearly all the samples of marine deposits collected during the past thirty years have passed through my hands, I shall endeavor briefly to point out what, in general, their detailed examination teaches with respect to the present condition of the floor of the ocean, and I will thereafter indicate what appears to me to be the bearing of some of these results on speculations as to the evolution of the existing surface features of our planet.

DEPTH OF THE OCEAN.

All measurements of depth, by which we ascertain the relief of that part of the earth's crust covered by water, are referred to the sea-surface; the measurements of height on the land are likewise referred to sea-level. It is admitted that the ocean has a very complicated undulating surface, in consequence of the attraction which the heterogeneous and elevated portions of the lithosphere exercise on the liquid hydrosphere. In the opinion of geodesists the geoid may in some places depart from the figure of the spheroid by 1,000 feet. Still it is not likely that this surface of the geoid departs so widely from the mean ellipsoidal form as to introduce a great error into our estimates of the elevations and depressions on the surface of the lithosphere.

The soundings over the water surface of the globe have accumulated at a rapid rate during the past fifty years. In the shallow water, where it is necessary to know the depth for purposes of navigation, the soundings may now be spoken of as innumerable; the 100-fathom line surrounding the land can therefore often be drawn in with much exactness. Compared with this shallow-water region, the soundings in deep water beyond the 100-fathom line are much less numerous; each year, however, there are large additions to our knowledge. Within the last decade over ten thousand deep soundings have been taken by British ships alone. The deep soundings are scattered over the different ocean basins in varying proportions, being now most numerous in the North Atlantic and Southwest Pacific, and in these two regions the contour lines of depth may be drawn in with greater confidence than in the other divisions of the great ocean-basins. It may be pointed out that 659 soundings taken quite recently during cable surveys in the North Atlantic, although much closer together than is usually the case, and yielding much detailed information to cable engineers, have, from a general point of view, necessitated but little alteration in the contour-lines drawn on the "Challenger" bathymetrical maps published in 1895. Again, the recent soundings of the German steamship "Valdivia" in the Atlantic, Indian and Southern Oceans have not caused very great alteration in the positions of the contour lines on the "Challenger" maps, if we except one occasion in the South Atlantic when a depth of 2,000 fathoms was expected and the sounding machine recorded a depth of only 536 fathoms, and again in the great Southern Ocean when depths exceeding 3,000 fathoms were obtained in a region where the contour lines indicated between 1,000 and 2,000 fathoms. This latter discovery suggests that the great depth recorded by Ross to the southeast of South Georgia may not be very far from the truth.

I have redrawn the several contour lines of depth in the great ocean-basins, after careful consideration of the most recent data, and these may now be regarded as a somewhat close approximation to the actual state of matters, with the possible exception of the great Southern and Antarctic Oceans, where there are relatively few soundings, but where the projected Antarctic expeditions should soon be at work. On the whole, it may be said that the general tendency of recent soundings is to extend the area with depths greater than 1,000 fathoms, and to show that numerous volcanic cones rise from the general level of the floor of the ocean basins up to various levels beneath the sea-surface.

The areas marked out by the contour lines of depth are now estimated as follows:

	Fms.	Sq. geo. m.	Per cent.
Between the shore and	100	7,000,000	(or 7 of the sea-bed.)
" 100 "	1,000	10,000,000	(or 10 " ")
" 1,000 "	2,000	22,000,000	(or 21 " ")
" 2,000 "	3,000	57,000,000	(or 55 " ")
Over 3,000 fathoms		7,000,000	(or 7 " ")
		103,000,000	100

From these results it appears that considerably more than half of the sea-floor lies at a depth exceeding 2,000 fathoms, or over two geographical miles. It is interesting to note that the area within the 100 fathom line occupies 7,000,000 square geographical miles, whereas the area occupied by the next succeeding 900 fathoms (viz. between 100 and 1,000 fathoms) occupies only 10,000,000 square geographical miles. This points to a relatively rapid descent of the sea floor along the continental slopes between 100 and 1,000 fathoms, and therefore confirms the results gained by actual soundings in this region, many of which indicate steep inclines or even perpendicular cliffs. Not only are the continental slopes the seat of many deposit slips and seismic disturbances, but Mr. Benest has given good reasons for believing that underground rivers sometimes enter the sea at depths beyond 100 fathoms, and there bring about sudden changes in deep water. Again, the relatively large area covered by the continental shelf between the shore line and 100 fathoms points to the wearing away of the land by current and wave action.

On the "Challenger" charts all areas where the depth exceeds 3,000 fathoms have been called "Deeps," and distinctive names have been conferred upon them. Forty-three such depressions are now known, and the positions of these are shown on the map here exhibited; twenty-four are situated in the Pacific Ocean, three in the Indian Ocean, fifteen in the Atlantic Ocean and one in the Southern and Antarctic Oceans. The area occupied by these thirty-nine deeps is estimated at 7,152,000 square geographical miles, or about 7 per cent. of the total water surface of the globe. Within these deeps over 250 soundings have been recorded, of which twenty-four exceed 4,000 fathoms, including three exceeding 5,000 fathoms.

Depths exceeding 4,000 fathoms (or four geographical miles) have been recorded within eight of the deeps, viz., in the North Atlantic, within the Nares Deep; in the Antarctic, within the Ross Deep; in the Banda Sea, within the Weber Deep; in the North Pacific, within the Challenger, Tuscarora, and Supan Deeps; and in the South Pacific, within the Aldrich and Richards Deeps. Depths exceeding 5,000 fathoms have been hitherto recorded only within the Aldrich Deep of the South Pacific, to the east of the Kermadees and Friendly Islands, where the greatest depth is 5,155 fathoms, or 530 feet more than five geographical miles, being about 2,000 feet more below the level of the sea than the summit of Mount Everest in the Himalayas is above it. The levels on the surface of the lithosphere thus oscillate between the limits of about ten geographical miles (more than eighteen kilometers).

TEMPERATURE OF THE OCEAN FLOOR.

Our knowledge of the temperature on the floor of the ocean is derived from observations in the layers of water immediately above the bottom by means of deep sea thermometers, from the electric resistance of telegraph cables resting on the bed of the great ocean basins and from the temperature of large masses of mud and ooze brought up by the dredge from great depths. These observations are now sufficiently numerous to permit of some general statements as to the distribution of temperature over the bottom of the great oceans.

All the temperatures recorded up to the present time in the sub-surface waters of the open ocean indicate that at a depth of about 100 fathoms seasonal variation of temperature disappears. Beyond that depth there is a constant, or nearly constant, temperature at any one place throughout the year. In some special positions and under some peculiar conditions a lateral shifting of large bodies of water takes place on the floor of the ocean at depths greater than 100 fathoms. This phenomenon has been well illustrated by Prof. Libbey off the east coast of North America, where the Gulf Stream and Labrador Current run side by side in opposite directions. This lateral shifting cannot, however, be called seasonal, for it appears to be effected by violent storms or strong off-shore winds bringing up colder water from considerable depths to supply the place of the surface drift, so that the colder water covers stretches of the ocean's bed which under normal conditions are overlaid by warmer strata of water. Sudden changes of temperature like these cause the destruction of innumerable marine animals, and produce very marked peculiarities in the deposits over the areas thus affected.

It is estimated that 92 per cent. of the entire sea floor has a temperature lower than 40° F. This is in striking contrast to the temperature prevailing at the surface of the ocean, only 16 per cent. of which has a mean temperature under 40° F. The temperature over nearly the whole of the floor of the Indian Ocean in deep water is under 35° F. A similar temperature occurs over a large part of the South Atlantic and certain parts of the Pacific, but at the bottom of the North Atlantic basin and over a very large portion of the Pacific the temperature is higher than 35° F. In depths beyond 2,000 fathoms the average temperature over the floor of the North Atlantic is about 2° F. above the average temperature at the bottom of the Indian Ocean and South Atlantic, while the average temperature of the bed of the Pacific is intermediate between these.

It is admitted that the low temperature of the deep sea has been acquired at the surface in polar and subpolar regions, chiefly within the higher latitudes of the southern hemisphere, where the cooled surface water sinks to the bottom and spreads slowly over the floor of the ocean into equatorial regions. These cold waters carry with them into the deep sea the gases of the atmosphere, which are everywhere taken up at the surface according to the known laws of gas absorption. In this way myriads of living animals are enabled to carry on their existence at all depths in the open ocean. The nitrogen remains more or less constant at all times and places, but the proportion of oxygen is frequently much reduced in deep water, owing to the processes of oxidation and respiration which are there going on.

The deep sea is a region of darkness as well as of low temperature, for the direct rays of the sun are wholly absorbed in passing through the superficial layers of water. Plant life is in consequence quite absent over 93 per cent. of the bottom of the ocean, or 66 per cent. of the whole surface of the lithosphere. The abundant deep-sea fauna, which covers the floor of the ocean, is, therefore, ultimately dependent for food upon organic matter assimilated by plants near its surface, in the shallower waters near the coast lines, and on the surface of the dry land itself.

As has been already stated, about 7,000,000 square geographical miles of the sea floor lies within the 100-fathom line, and this area is in consequence subject to seasonal variations of temperature, to strong currents, to the effects of sunlight, and presents a great variety of physical conditions. The planktonic plant life is here reinforced by the littoral sea weeds, and animal life is very abundant. About 40 per cent. of the water over the bottom of this shallow water area has a mean temperature under 40° F., while 20 per cent. has a mean temperature between 40° and 60° F., and 40 per cent. a temperature of over 60° F.

It follows from this that only 3 per cent. of the floor of the ocean presents conditions of temperature favorable for the vigorous growth of corals and those other benthonic organisms which make up coral reefs and require a temperature of over 60° F. all the year round. On the other hand, more than half of the surface of the ocean has a temperature which never falls below 60° F. at any time of the year. In these surface waters, with a high temperature, the shells of Pelagic Mollusks, Foraminifera, Algæ, and other planktonic organisms are secreted in great abundance, and fall to the bottom after death.

It thus happens that, at the present time, over nearly the whole floor of the ocean we have mingled in the deposits the remains of organisms which had lived under widely different physical conditions, since the remains of organisms which lived in tropical sunlight and in water at a temperature above 80° F. all their lives, now lie buried in the same deposit on the sea floor, together with the remains of other organisms which lived all their lives in darkness and at a temperature near to the freezing point of fresh water.

(To be continued.)

THE MANUFACTURE OF SILKWORM GUT IN ITALY.

SOME of the inhabitants of the island of Procida, says The Journal of the Society of Arts, manufacture very fine gut from silkworms. They call the product "fili di seta," or "silk threads," their special properties consisting in their strength and flexibility. They are made from the stomachs of silkworms just before they begin to spin their silk, and from their cocoons. Not many worms, in proportion to the gut put on the market, are reared in Procida itself, but the makers buy them from Torre dell' Annunziata, and other neighboring towns, in great quantities. The following, according to Consul Neville-Rolfe, is the process of manufacture: The worm is selected when fully

matured, that is to say, at the moment when his nourishment ceases, and just before his metamorphosis. He is then cut open, great care being taken not to injure the membrane of the stomach. This is then removed, and the stomachs are then put into a pickle, which is the keynote of the whole process, and the secret of which is carefully kept. When the pickling process is over the workpeople, who are mostly women, take one end of the stomach in their teeth, and draw the other end with their hands. This part of the work requires great dexterity, for the threads are drawn out to a considerable length, the whole value of the product depending, in fact, upon its length in relation to its thickness, and the strain it will carry. There are two seasons for the production, namely, in spring, when the best gut is produced; and in autumn, when the quality is inferior. There is one important market for this specialty, and the whole production is exported to Northern Italy and abroad, at the average price of £3 per pound. The gut is of very small specific gravity, so that a great deal of it goes to a pound-weight. The cost of production is also considerable, as the worms must be bought just at the moment when they are coming into profit for making silk, that is to say, when they are dearest. Again, the results are frequently disappointing, many worms being found, on dissection, not to be suitable, and have to be discarded. The various operations require a good many hands, and although labor is cheap it runs away with a good deal of money, as skilled hands are alone satisfactory. The gut is used for fishing tackle, brushes, and any purpose where fineness and tenacity are jointly requisite.

AGRICULTURE IN MEXICO.

IN Mexico irrigation is necessary in the greater portion of the country, and, on account of the scarcity of water, a large extent of land cannot be utilized. When the owner of land has sufficient water for the purpose indicated, he retains his property, and rarely can be induced to sell, as it is of permanent value to him. For the last three hundred years large tracts of land have been owned by individuals or families, who have spent heavy sums of money for canals and dams in order to make them productive. The United States Consul-General at Monterey says that on account of this, and the attending expenses of irrigation, there are fewer small farmers in Mexico than there are in the United States. Until recently farming in Mexico has been of the primitive order; but the Mexican is an expert in irrigation, and if he can get the water, his land becomes fertile and yields generously. During the last two decades decided improvements have been accomplished through the introduction of modern improvements into farming in Mexico. The increase in production corresponds to the improvements in farming apparatus. The great railroads of the country have been important factors in this advance, enabling farmers with a surplus of production to supply those less fortunate. The cost of labor is from 6d. to 1s. per day, depending on the locality. There are two crops of corn a season, upon which the former averages about £5 per acre gross. Sugar cane, turned into piloncillo or brown sugar, averages from £14 to £19 per acre gross; beans, from £6 to £8 per acre; rice, from £7 to £9 per acre; all other products realizing correspondingly high prices. Thus it will be seen that the profits of the farmer must be large. Hay is not made in any great quantity, but corn fodder is sold to advantage. Near the cities, a lucrative trade is carried on in green barley and corn, which are cut before maturity and delivered in the cities to owners of horses and cows. Cattle breeding is, and always has been, a profitable business in Mexico, consequent upon cheap labor, low taxes, and the large tracts of cheap land which are suitable for grazing only. Until recently, no attempt has been made to improve the stock, but certain large cattle-men have now undertaken to do this, and steady improvement is certain henceforth. The demand created during the late war with Spain, and the high prices which obtained in the United States, increased the price of cattle to such an extent that the nothern portion of the country has become depopulated of its stock, which, it is said, will take several years to replenish. Dairy farming in the neighborhood of large cities is lucrative, milk selling at 1s. per gallon, and butter at 1s. 6d. to 2s. per pound. Those engaged in this business make money rapidly. Fruit and vegetable farming are beginning to attract attention. Formerly this amounted to simply enough for the home market. Now an effort is to be made to supply the United States with early fruit and vegetables. The movement is in its infancy, but it is expected to grow into large proportions. Oranges, lemons, tomatoes, beans, etc., are produced in Mexico from four to eight weeks earlier than in the United States. Hence this is expected to be a profitable business in the near future. Wheat is cultivated in the high table-lands of Central Mexico, and is fairly profitable. It is not the equal of that grown in the United States, either in quantity per acre, or quality. Para and Bermuda grass give pasturage in many sections of the country. They are said to be equal to any in the world. Parts of the country are adapted to the growth of tropical products, viz., coffee, vanilla, rubber, coconut, cocoa, etc., the quality of all being excellent. It is said that the best vanilla of the world comes from the State of Vera Cruz, and the best cocoa from the State of Chiapas. The coffee of Michoacan is said to be equal to any; the tobacco of Vera Cruz is preferred by many to that of Havana, and the sugar production of southern Tamaulipas, or northern Vera Cruz, is said to be surpassed by that of no country save Hawaii in quantity, and it is more profitable to the producers, for the reason that seven to ten crops are the result of one planting, whereas the Hawaiian planters get only two. Taken as a whole, farming in Mexico is an inviting field for persons of capital and intelligence.—Journal of the Society of Arts.

According to The Railway and Engineering Review, twenty-seven loads of structural material have been shipped to Paris for the erection of a building 343 feet long and 74 feet wide, which will be equipped with motive power in order that American exhibitors may show their machinery in actual operation, and, at the same time, make an exhibit of a typical American machine shop with all modern appliances.

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